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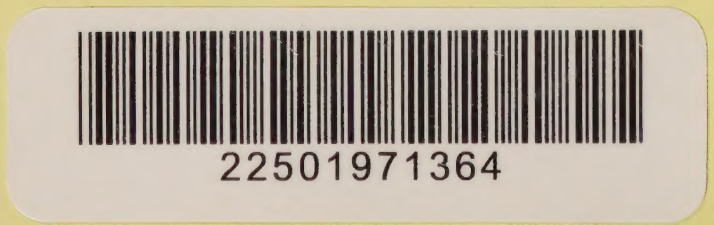

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PUBLIC HEALTH.

REPORTS

OF

THE MEDICAL OFFICER OF THE PRIVY COUNCIL AND LOCAL GOVERNMENT BOARD.

NEW SERIES, No. II.

SUPPLEMENTARY REPORT TO THE LOCAL GOVERNMENT BOARD ON SOME RECENT INQUIRIES UNDER THE PUBLIC HEALTH ACT, 1858.

Presented to both Houses of Parliament by Command of Her Majesty.

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To The Right Honorable the President of the Local Government Board.

Sir,

In my recent Annual Report, when adverting to the list which I then submitted of inspections made under you by this Department during the year 1873, I stated that some of the cases had been of so much sanitary interest that I would, as soon as I could, bring them more particularly under your notice in a separate Supplementary Report.

My reference was especially to three very instructive outbreaks of Enteric or Typhoid Fever which had been investigated within the year: but I find that with them I can advantageously associate two other of our departmental cases which have had an exactly similar interest; and I accordingly beg leave to draw your attention to the subjoined reports of the Inspectors by whom the five outbreaks were investigated.

Enteric Fever, in regard of its mode of origin, seems to me the type of so vast a quantity of preventable disease as to claim, in an administrative point of view, the earliest and most vigilant attention of the Local Government Board. I therefore, at the opportunity of bringing the present special instances under your notice, and by way of preface to them, would submit to you some observations in which I have sought to embody the general experience of this Department with regard to Enteric Fever and the diseases which in preventability are most akin to it. I also annex, as of very valuable aid to the purpose of these observations, Mr. Netten Radcliffe's report of the results of a large inquiry, on which he has recently been engaged, with regard to that branch of local sanitary administration which is most concerned with the prevention of Enteric Fever.

I have the honor to be, Sir,
Your obedient Servant,
John Simon.

Medical Department;
July 29th, 1874.

MEDICAL OFFICER'S SUPPLEMENTARY REPORT.

Filth-Diseases and their Prevention.

I.

1.—In the subject-matter of Preventive Medicine, considered with reference to the administrative needs of England at the present time, Enteric Fever, with the diseases which are allied to it in mode of origin, must necessarily, I think, stand as first topic: and I avail myself of this earliest opportunity to submit to the Local Government Board some observations on that class of diseases.

That very much disease is preventable, is the *raison d'être* of sanitary authorities.

2.—In my recent Annual Report, the vast amount of injury which is suffered day by day in this country through diseases well known to be preventable was referred to in regard of the responsibility which it imposes on all who have undertaken to serve in the new sanitary organisation of the country; and I submitted that "the Local Government Board, viewed as a Central Board "of Health, and the more than fifteen hundred District-Authorities "which, each with its Medical Officer of Health, locally administer the Health Laws, may be regarded as having had their "respective functions assigned to them in special and systematic "relation to that state of things."

Among the consequences of preventable disease, only the deaths can be counted.

3.—I do not pretend to give any exact statement of the total influence which preventable diseases exert against the efficiency and happiness of our population; for it is only so far as such diseases kill, and even thus far but very imperfectly, that the effect can be represented in numbers. Of the incalculable amount of physical suffering and disablement which they occasion, and of the sorrows and anxieties, the often permanent darkening of life, the straitened means of subsistence, the very frequent destitution and pauperism, which attend or follow such suffering, death-statistics, to which alone I can refer, testify only in sample or by suggestion.

Rough estimate of the mortality which is preventable:

4.—That the deaths which we in each year register in this country (now about half a million a year) are fully 125,000 more numerous than they would be if existing knowledge of the chief causes of diseases, as affecting masses of population, were reasonably well applied throughout England, is, I believe, the common conviction of persons who have studied the subject. The statistical considerations which in the first instance suggest that conclusion have so long and so admirably been put before the public in the successive Reports of the Registrar-General that I need but very briefly, and only by way of illustration, advert

to them. Looking at England as a whole, we see that of each 100 persons who die, not quite 10 have reached the standard old age of seventy-five years; and that of each 100 children born hardly 74 complete five years of life. We next see what appears to be a widely different expectation of life in different districts of the country: that while, for instance, in a considerable proportion (about a seventh of the number) of the districts into which England is divided for registration-purposes, the death-rate of infants in the first year of life, ranges from 8 to 12 per cent., there is a still larger proportion of districts in which it ranges even from 19 to 30; and that, under the influence of these Herodian districts the infant death-rate of England as a whole stands at the high average of 18. Similarly, taking the death-rate of the population at all ages living, we find that the present general English death-rate of about 22½ per 1,000 per annum, covers on the one hand local death-rates ranging from 13 to 17, and on the other hand local death-rates which range even to far above 30. Primâ facie, then, it would seem that influences hostile to life must be operating in parts of England far more vehemently than in other parts; and we turn to the registered "causes of death" to learn from them, if we can, under what peculiarities of local assessment life is so differently taxed or mulcted in the different parts of this one country. Here of course we have to proceed with caution; for alleged causes of death may be registered on very imperfect non-medical testimony; and even medical certificates (since rapidly growing knowledge cannot be equally distributed in a very large and wide-spread profession) may in variable proportions be so inexact or arbitrary in their naming of the causes of death as to be unavailable for comparisons in this respect. With due caution, however, cases of this sort can be set aside, or the fallacies which they would introduce be guarded against; and when, with such caution, different districts are compared in regard of the causes of death registered in them, this finer sort of comparison adds very greatly to the force of the rougher comparisons which were first made; for, so far as the register of "causes of death" can intelligibly answer us, it says that certain sorts of disease—and those just the sorts which we in other ways know to be the most preventable, are very greatly more fatal in some districts of England than in others. This statistical conclusion, as based on the local death-returns which are made to the Registrar-General, was to some extent indicated by Dr. William Farr more than 30 years ago in the earlier annual reports of the General Register Office, and was afterwards more fully established and discussed in an important paper by Dr. Greenhow which I had the honour of laying before the General Board of Health in 1858.*

* "Papers relating to the Sanitary State of the People of England: being the Results of an Inquiry into the different Proportions of Death produced by certain Diseases in different Districts in England; communicated to the General Board of Health by Edward Headlam Greenhow, M.D., with an Introductory Report by the Medical Officer of the Board on the Preventability of certain Kinds of Premature Death."

From the passing of the Public Health Act of that year, the unequal distribution of different diseases in England became matter for detailed medical investigation and advice under the Privy Council; and in proportion as particular districts have been medically inspected with regard to the prevalence in them of the particular diseases to which attention had been drawn, so has evidence become more and more complete, with regard to the dependence of vast annual excesses of disease and death on causes which in the most moderate sense may be called removable.

preventable, namely, under action of law.

The causes of disease to which I here refer as removable are exclusively such as contravene Public Hygiene: such, namely, as affect more or less in common the mode of life of masses of population, and such as in most, if not in all instances, are already understood to be under ban of law. Doubtless much disease is also produced, and much life consequently wasted, through causes which are within the province of Private Hygiene; causes, which either are not of massive operation, or may at least easily be escaped at individual option, and which the law does not, and generally could not, take within its scope; but to such causes I do not advert as removable in the sense of my present argument.

Of removable causes of disease, the chief is uncleanliness:

5.—Among causes which injuriously affect the Public Health of England, considered as a total, certain operate only in particular districts: as, for instance, some large adjacency of malarious or water-logged land, or some prevalent injurious industry: while others, though no doubt in widely different degrees, appear to be of general, perhaps nearly universal, operation. Foremost in the latter class, and constituting therefore in my opinion objects which claim earliest attention in the sanitary government of England, two gigantic evils stand conspicuous:—

first, the omission (whether through neglect or through want of skill) to make due removal of refuse-matters, solid and liquid, from inhabited places; and,

secondly, the licence which is permitted to cases of dangerous infectious disease to scatter abroad the seeds of their infection.

In certain very important cases, injury—immense injury, accruing to the public health, arises from a co-operation of these two evils: arises, namely, through the special facility which (as I shall presently illustrate) certain forms of local uncleanliness provide for the spreading of certain specific infections; and the influence which uncleanliness almost necessarily exerts in that way against the public health, make so large an addition to the influence which it exerts in other ways, that, in total power, uncleanliness must, I think, without doubt, be reckoned as the deadliest of our present removable causes of disease.

and particularly in the degrees which constitute Filth.

In stating this opinion of its fatal influence, I do not refer to it in its minor degrees, as compared with high standards of cleanliness or chemical purity, but refer chiefly to such degrees of it as fall, or ought to fall, within the designation of FILTH:—to

degrees, namely, which in most cases obviously, and in other cases under but slight mask, are such as any average man or woman should be disgusted at: such as, eminently, the presence of putrescent refuse-matter, solid and fluid, causing nuisance by its effluvia and soakage. Also in imputing to Filth, as thus illustrated, that its effluvia are largely productive of disease, I do not ignore that disease is also abundantly caused by air which is fouled in other ways. Particularly I do not forget the effluvia of overcrowding: that, within dwellings which are populated beyond their means of ventilation, the foulness of air, due to the non-removal of the volatile refuse of the human body, is as strictly within the physiologist's definition of Filth, and as truly a nuisance within the scope of sanitary law, as any non-removal of solid or liquid refuse: but for the purpose of my present observations, the question of overcrowding is something to be set aside as distinct, and the word "Filth" is therefore here used distinctively in that sense which suggests subject-matter for sewers and scavenging.

Old general knowledge of the hurtfulness of Filth.

6.—It has been among the oldest and most universal of medical experiences that populations, living amid Filth, and within direct reach of its polluting influence, succumb to various diseases which under opposite conditions are comparatively or absolutely unknown; and the broad knowledge that Filth makes Disease is amply represented in the oldest records which exist of legislation meant for masses of mankind. The exacter studies of modern times have further shewn that by various channels of indirect and clandestine influence (some of which I shall presently illustrate) Filth can operate far more subtly, and also far more widely and more destructively, than our forefathers conjectured. The later almost equally with the former knowledge, the finer almost equally with the more general, is indispensable for sanitary administration in modern times; and Filth is little likely to be guarded against with that thoroughness of detail which present science shows to be necessary, unless the detail follow some intelligent appreciation of the ways in which Filth becomes destructive. This more exact knowledge, though it owes its origin to medical observation, and will no doubt constantly be receiving additions from the same source, is such as at least all well-educated persons of the general public may be expected gradually to acquire and apply; and I believe that our newly instituted Medical Officers of Health will be rendering not their least service to the public, when they shall make their own possession of this branch of medical knowledge, and their consequent power of interpreting many obscure productions of disease, subservient to the education of the laity among whom they act.

Modern, more particular, knowledge of its modes of hurtful operation.

7.—An important suggestion of modern science with regard to the nature of the operations by which Filth, attacking the human body, is able to disorder or destroy it, is: that the chief morbific agencies in Filth are other than those chemically-identified stinking gaseous products of organic decomposition which force

themselves on popular attention. Exposure to the sufficiently concentrated fumes of organic decomposition (as for instance in an unventilated old cesspool or long-blocked sewer) may, no doubt, prove immediately fatal by reason of some large quantity of sulphide of ammonium, or other like poisonous and fœtid gas, which the sufferer suddenly inhales; and far smaller doses of these fœtid gases, as breathed with extreme dilution in ordinary stinking atmospheres, both give immediate headache and general discomfort to sensitive persons temporarily exposed to them, and also appear to keep in a somewhat vaguely depressed state of health many who habitually breathe them: but here, so far as we yet know, is the end of the potency of those stinking gases. While, however, thus far there is only the familiar case of the so-called *common chemical poison,* which hurts by instant action and in direct proportion to its palpable and ponderable dose, the other and far wider possibilities of mischief which we recognise in Filth are such as apparently must be attributed to *morbific ferments* or *contagia;* matters which not only are not gaseous, but on the contrary, so far as we know them, seem to have their essence, or an inseparable part of it, in certain solid elements which the microscope discovers in them: in living organisms, namely, which in their largest sizes are but very minute microscopical objects, and at their least sizes are probably unseen even with the microscope; organisms which, in virtue of their vitality, are indefinitely self-multiplying within their respective spheres of operation, and which therefore, as in contrast with common poisons, can develop indefinitely large ulterior effects from first doses which are indefinitely small. Of ferments thus characterised, the apparently essential factors of specific chemical processes, at least one sort—the ordinary septic ferment*—seems always to be present where putrefactive changes are in progress, as of course in all decaying animal refuse; while others, though certainly not essential to all such putridity, are in different degrees apt, and some of them little less than certain, to be frequent incidents of our ordinary refuse. As, apparently, it is by these various agencies (essential and incidental) that Filth produces "zymotic" disease, it is important not to confound them with the fœtid gases of organic decomposition; and the question, what infecting powers are prevalent in given atmospheres, should never be regarded as a mere question of stink. It is of the utmost practical importance to recognise in regard of Filth, that agents which destroy its stink may yet leave all its main powers of disease-production undiminished. Whether the ferments of disease, if they could be isolated in sufficient quantity, would prove themselves in any degree odorous, is a point on which no guess needs be hazarded; but it is certain that in doses in which they can fatally infect the human body they are infinitely out of reach of even the most

* For convenience I use the singular number, but have no intention of implying that ordinary putrefactive changes have only one ferment which can be considered habitual to them.

cultivated sense of smell, and that this sense (though its positive warnings are of indispensable sanitary service) is not able, except by indirect and quite insufficient perceptions, to warn us against risks of morbid infection. Even as regards the positive notices which we receive by the sense of smell with regard to putrefactive decomposition, we must not assume that the diffusion and potency of septic ferment in the air necessarily go pari passu with the diffusion and offensiveness of the fœtid gases:—Witness, on a very large scale, the experience of London in the summer of 1858; when, as persons who were then frequenting Westminster may well remember, our tidal river, enormously charged with decomposing sewage, stank week after week in a degree which excited much public alarm as to the possible consequences of the nuisance, and even led to an immediate interference of the Legislature;* but when, though the quantity of sulphuretted hydrogen in the river-atmosphere was such as rapidly to blacken the ordinary chemical test-papers, as well as to affect in the same way the lead-paint of vessels on the river, and was enough also to produce among persons much engaged on the river such signs of sulphide-poisoning as I have above mentioned, the particular ailments which attest the working of septic ferment on the human body were in even less than average prevalence among the unwilling subjects of this large experiment.†

Filth-ferments in their relation to air:

It must be remembered that gases on the one hand, and the particulate ferments on the other, stand in widely different relations to air and water as their respective media of diffusion. The ferments, so far as we know them, shew no power of active diffusion in dry air: diffusing in it only as they are passively wafted, and then probably, if the air be freely open, not carrying their vitality far: but, as moisture is their normal medium, currents of humid air (as from sewers and drains) can doubtless lift them in their full effectiveness, and, if into houses or confined exterior spaces, then with their chief chances of remaining effective: and ill-ventilated low-lying localities, if unclean as regards the removal of their refuse, may especially be expected to have these ferments present in their common atmosphere, as well as of course teeming in their soil and ground-water.

and to water.

Considerations like some which I have stated in regard of infective air apply equally to infective water. In the latter, just as in the former, the zymotic malignity is but indirectly and most imperfectly suggested to us by qualities which strike the common sense, or by matters which chemical analysis can specify. As any unbrutalised sense of smell will turn with disgust from certain airs, so will it, and common taste and sight, be repelled by certain waters; and as the chemist can shew certain foulnesses in the one, so he can shew certain foulnesses in the other; but these

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* See the word "speedily" in the preamble of the amending Metropolis Local Management Act, 21 & 22 Vict., c. 104.

† The particulars of this very interesting experience are given in my Second Annual Report to the Privy Council, pp. 54–6, in a paper for which I was indebted to Dr. Ord, now Senior Assistant Physician to St. Thomas's Hospital.

tests, it must always be remembered, are tests only of the most general kind. Confessedly they do not touch the *corpus delicti*, but only certain conditions to which it is or may be collateral; and their negative findings are consequently not entitled to the same sort of confidence as their positive. Chemical demonstration of unstable nitrogenous compounds in water is a warning which of course should never be disregarded: but till chemistry shall have learnt to identify the morbific ferments themselves, its competence to declare them absent in any given case must evidently be judged incomplete, and waters which chemical analysis would probably not condemn may certainly be carrying in them very fatal seeds of infection.

Excess of disease in filthy places not always due only to the Filth;

8.—Populations under the influence of Filth are in many cases suffering not only from that influence, but also from other removable causes of disease; and in any endeavour to estimate at all exactly, as for administrative judgment, the injury which is derived from Filth, evidently those additional influences should as far as practicable be made matter of separate account. In one case a filthy neighbourhood may be so poor that mere privation is an appreciable cause of disease in it. In another case, the population may be so badly housed in respects which by themselves would not be classed as Filth,—may be so overcrowded in their dwellings, or be inhabiting such close or ill-built quarters, that this has to be counted as causing disease. In a third case, some particular collective occupation, injurious to the adults and adolescents who follow it, may be creating disease additional to that which the Filth produces. In a fourth case, swarms of infants and young children, whose mothers are engaged away from home in some local industry, may be suffering disease from neglect and mismanagement: and so forth. And evidently if one would see what harm Filth can do in its own ways, one must discriminate it as far as possible from such concomitants as the above.

but notwithstanding mixed cases, the hurtfulness of the Filth is certain.

In filthy urban districts, where the foul air, comparatively incarcerated in courts and alleys and narrow streets, can act with most force in regard to masses of population, the population always shews an increased mortality under several titles of disease. Such miscellaneous increase of mortality affects probably all ages, more or less, but a distinctively large proportion of it attaches to the children. Apparently the mere influence of the Filth (apart from other influences) in such a district will be causing the infants and young children to die at twice or thrice or four-times their fair standard rate of mortality; and this disproportion, which becomes even more striking when the chief epidemics of ordinary childhood (measles and whooping-cough and scarlatina) are left out of the comparison, seems to mark the young lives as finer tests of foul air than are the elder and perhaps acclimatised population.

In trying to analyse the death-statistics of filthy districts, we soon find that, with regard to many of the separate elements in the miscellaneous mortality, we cannot argue in exact scientific terms: partly because very large quantities are registered under names

which have no definite nosological meaning,—e.g. "convulsions," "teething," "atrophy," "consumption"; partly also because some kinds which we can fairly identify by name (e.g. pneumonia) are such as we do not always ætiologically understand; and sometimes we may be only able to establish the broad fact that, within the area of Filth, the deaths, in total amount, are greatly more numerous than ought to be, and that the excess (or in mixed cases a certain share of the excess) can only be accounted for as the effect of the Filth. Though, when that broad conclusion is reached, more detailed conclusions may at first sight scarcely seem wanted for practical purposes, yet there is advantage in establishing the details of each case as exactly as the circumstances will allow; not only because it greatly concerns the progress of preventive medicine that all our attributions of cause and effect should be in the spirit of exact science, but also because in regard to filthy rural districts the argument from general death-rates would often be insufficient to carry conviction: and I therefore proceed to speak with some particularity of individual diseases which can be traced to Filth.*

Of diseases distinctively due to Filth, the most characteristic are the diarrhœal.

9. In all filthy districts, one particular class of diseases seems specially apt to stand in relief: the diseases, viz., which, in respect of their leading symptom, may be generalised as diarrhœal. These diseases, in their relation to Filth, deserve very special attention: first, on their own account, as extremely large causes of death; and secondly, because an exact knowledge of their method of production is likely to throw comparative light on the pathology of obscurer filth-diseases.

Common diarrhœa, and its relation to Filth.

A certain large quantity of endemic diarrhœa is medically spoken of as "common," in contrast with such so-called "specific" diarrhœal diseases as cholera and enteric fever. Perhaps in a certain sense all might equally claim to be called "specific:" since, no doubt, each distinct effect has essentially its own distinct cause: but at least provisionally the contrast of terms is convenient, because much "common" filth-produced diarrhœa (with perhaps much else of the miscellaneous mortality of the same districts) may reasonably be ascribed to infection with the "common" septic ferment which is an attribute of all filth. Among the effects which arise under experimental septic infections, as likewise in cases of accidental septicæmia in the human subject, acute catarrh of the mucous membrane of the intestines is an extremely prominent fact. The mucous membrane of the intestinal canal seems peculiarly to bear the stress of all accidental pūtridities which enter the blood. Whether they have been breathed or drunk or eaten, or sucked up

* I would note that, writing here on these diseases only for immediate practical purposes, I am obliged to leave unnoticed various of the more scientific aspects of the subject. As I must thus leave undiscussed the very interesting question of the influence of particular soils and seasons in favoring epidemics of Filth-Disease, I would the more especially refer to the very valuable and suggestive writings of Professor v. Pettenkofer, of Munich, on this branch of the study of Cholera and Enteric Fever.

into the bloodvessels from the surface of foul sores, or directly injected into bloodvessels by the physiological experimenter, there peculiarly the effect may be looked for: just as wine, however administered, would "get into the head," so the septic ferment, whencesoever it may have entered the blood, is apt to find its way thence to the bowels, and there, as universal result, to produce diarrhœa.

Enteric fever and its relation to excremental infection.

10.—It seems certain, however, that in the high diarrhœal mortality of filthy places, infections, of the sorts already recognised as "specific," exercise always a very great influence: and in the studies which have made a basis for the suggestions of preventive medicine in relation to Filth, none have hitherto been so instructive as the study of these "specific" filth-infections. To them I would now particularly advert; referring first to the disease which of late years has for sufficiently sad reasons become well known to the public of this country under the name of Enteric or Typhoid Fever.

Since the year 1849, when Dr. (now Sir William) Jenner made known his conclusive and masterly discrimination of this specific form of fever, successive studies have tended with singular uniformity to connect it in regard of its origin with nuisances of an excremental sort.* In illustration of that fact in the natural history of enteric fever, I may refer to an abstract which I append of the experience of the Medical Department during the four years 1870–3 in this particular branch of disease-production: and such illustrations might be multiplied to any desired extent. The experience is, not only that privies and privy-drainage, with their respective stinkings and soakings, and the pollutions of air and water which are thus produced, have in innumerable instances been the apparent causes of outbreaks of enteric fever, but, further, that they have seemed capable of doing this mischief in a doubly distinctive way: first, as though by some aptitude which other nuisances of organic decomposition, though perhaps equally offensive, have not seemed equally or nearly equally to possess; and secondly, as though this specific property, so often attaching to them in addition to their common septic unwholesomeness, were not, even in them, a fixed property. The explanation of this experience, the explanation of the frequent but not invariable tendency of privy-nuisances to infect with enteric fever, has seemed to consist in the liability of such nuisances to carry with them, not invariably, but as frequent accidental adjuncts, the "specific" contagium of any prevailing bowel-infection: for presumably the privies of a population receive (inter alia) the diarrhœal discharges of the sick; and it has long been matter of fair pathological presumption that in any "specific" diarrhœa (such as eminently is enteric fever) every discharge from

*The very able writings of Dr. Murchison, dating from a paper by him in the Medico-Chirurgical Transactions of 1858, have been of particular influence in that contention.

the bowels must teem with the contagium of the disease.* Medical knowledge in support of this presumption has of late been rapidly growing more positive and precise; and at the moment of my present writing I have the gratification of believing that under my Lords of the Council it has received an increase which may be of critical importance, in a discovery which seems to give us for the first time an ocular test of the contagium of enteric fever: in the discovery, namely, of microscopical forms, apparently of the lowest vegetable life, multiplying to innumerable swarms in the intestinal tissues of the sick, penetrating on the one hand from the mucous surface into the general system of the patient, and contributory on the other hand, with whatever infective power they represent, to the bowel-contents which have presently to pass forth from him.† Adverting then summarily, in an administrative point of view, to the present state of medical knowledge and opinion as to the way in which enteric fever spreads its infection in this country, I would say that it is difficult to conceive, in regard to any causation of disease in a civilised community, any physical picture more loathsome than that which is here suggested: that apparently, of all the diseases which are attributable to Filth, this, as an administrative scandal, may be proclaimed as the very type and quintessence: that, though sometimes by covert processes which I will hereafter explain, yet far oftener in the most glaring way, it apparently has an invariable source in that which of Filth is the filthiest: that apparently its infection runs its course, as with successive inoculations from man to man, by instrumentality of the molecules of excrement which man's filthiness lets mingle in his air and food and drink.

Cholera, and its relation to excremental infection.

11.—It seems certain that the distribution in England of an immense quantity of other specific disease must exactly follow that disgusting type. The local affinities of Asiatic Cholera, when present in this country, have always been so close to those of enteric fever, in respect of its association with circumstances of excremental filth, and the lines of pathological argument on this association (even apart from evidence which has been alleged on the direct communicability of cholera to the lower animals) are so parallel in the two cases, that no reasonable doubt can, I think, be entertained as to the substantial dependence of cholera-epidemics in this country on the opportunities which are ever widely open

* This is the argument of the late Dr. John Snow: which though urged by him more particularly in relation to Asiatic Cholera, was meant by him to have general application, and was expressly applied by him to enteric fever. In the latter relation it has from 17 years ago been constantly and very powerfully urged by Dr. Wm. Budd, of Clifton. From the beginning of our European experiences of cholera the doctrine of the specific infectiveness of the discharges in the disease had been argued by Dr. von Gietl of Munich, to explain, as he maintained, the atmospheric diffusion of the epidemic influence.

† This discovery (as I believe it to be) of the microphyte of enteric fever is the work of Dr. Klein, Assistant-Professor in the Brown Institution, and arose in one of the *Scientific Investigations in aid of Pathology and Medicine* which I have the honor of superintending under my Lords of the Council. The details of the subject are still undergoing investigation at Dr. Klein's hands.

for the above-described filthy method of infection. Indeed, with regard to the manner of spread of the entero-zymotic diseases generally, it deserves notice that the whole pathological argument which I am explaining grew among us in this country out of the very cogent facts which our cholera-epidemics specially supplied, and to which the late Dr. John Snow, twenty-five years ago, had the great merit of forcing medical attention: an attention at first quite incredulous, but which, at least for the last fifteen years, as facts have accumulated, has gradually been changing into conviction.

Similar relation of other diseases.

12.—The argument which applies to the bowel-discharges of Cholera and Enteric Fever, and which, in regard of them, rests on a very large quantity of detailed evidence, seems to extend by extremely strong analogy to every disease, whether nominally "common" or "specific," in which the human intestinal canal is the seat of infected changes: chiefly perhaps to such diarrhœal and dysenteric infections as are exclusively or distinctively intestinal, but likewise, I apprehend, more or less, to every general infection (such for instance as scarlatina) in proportion as it inclusively infects the bowels: and it would thus seem probable that air and water, having in them the taint of human excrement, must often carry with them, whithersoever they pass, the seeds of current morbid infections.

Powers of common septic infection to produce disease.

13.—But though hitherto, for convenience of argument, I have referred specially to the influence of human excrement in determining the spread of "specific" infections from man to man, and provisionally as if man's body were the sole birth-place of the several contagia which afflict his kind, assuredly that intermediary influence is but part, and it may be but a very subordinate part, of the faculty by which Filth produces disease. While it is indeed true as regards some contagia that at present we know them only as incidents of the human body, wherein we see them in case after case multiplying their respective types with a successivity as definite and identical as that of the highest orders of animal or vegetable life,—and while thus it is at present true, for instance, of smallpox or syphilis, that a case arising independently of a previous like case is hitherto practically as unknown to us as the parentless production of dog or cat, our knowledge with regard to other very important contagia is growing to be of larger scope. I would mention it as among the most hopeful advances of modern preventive medicine, that some diseases, which, in the sense of being able to continue their species from man to man, are apparently as "specific" as those which I have above-named, seem now beginning to confess in detail a birth-place exterior to man, a birth-place amid controllable conditions in the physical nature which is around us, a birth-place amid the "common," putrefactive changes of dead organic matter. Referring again now to what I have not pretended to be able to analyse in detail—the excess of miscellaneous, and in great part nominally "common," disease in filthy neighbour-

hoods, I would particularly wish to connect with that subject a reference to our growing scientific knowledge in the matter of the "common" septic ferment. The pathological studies of late years, including eminently certain very instructive researches which Professor Sanderson has conducted under my Lords of the Council, have clearly shewn that in the "common" septic ferment, or in some ferment or ferments not hitherto to be separated from it, there reside powers of disease-production as positive, though not hitherto as exactly defined, as those which reside in the variolous and syphilitic contagia. Experimentally we know of this ferment, that, when it is enabled by artificial inoculations to act in its most effective way on the animal body, and even more when it has received a curious increment of strength which its first propagation within the living body seems to bestow on it, it shews itself one of the most tremendous of zymotic poisons. It rapidly in the one animal body develops disease which then is communicable to another: febrile disease, with inflammations numerous and intense, and including in marked degree one of the acutest known forms of intestinal inflammation and flux: disease exactly corresponding to certain very fatal and unfortunately not infrequent infections to which lying-in women, and persons with accidental wounds and the wounds of surgical operations, are most subject, but which also sometimes occur independently of such exceptional states; infections, chiefly known under the names of erysipelas, pyæmia, septicæmia and puerperal fever; infections, which we sometimes see locally arising anew in unquestionable dependence on Filth, but of some of which, when arisen, it is perfectly well known that they are among the most communicable of diseases. And a further, perhaps still more instructive, teaching of the artificial infections is this: that the "common" ferment, which in its stronger actions quickly destroys life by septicæmia, can in slighter actions start in the infected body chronic processes which will eventuate in general tubercular disease. I need hardly point out that the above facts, extremely suggestive though they are, must of course, in relation to my main argument, be applied only under certain reserve; that evidently the exact conditions of the physiological experiment are not reproduced in ordinary life; and that against the common septic ferment, as presented in fouled atmosphere or fouled drinking water, the living human body in its normal state can apparently make considerable (though presumably not unlimited) resistance. But after all such reserves the truth remains, that, looking well at the pathology of human life under residence in foul air, we find ourselves again and again reminded of these results of physiological experiment: often seeing phthisis and other tubercular and like diseases gradually developed, as though under gradual overpowering of the limited normal resistance to the septic ferment; or seeing—and particularly where some exceptional bodily state (wounded or puerperal) gives opportunity, the sudden invasion of erysipelas or other septic infection, not in discoverable dependence on any human infectant, but conceivably a filth-

inoculation from the air.* The line of reflection thus suggested is one which I cannot now follow further, but of which the practical interest seems to be extremely great. For, while the excessive production of fatal disease in filthy neighbourhoods is a fact as to which there can be no doubt, and of which the immediate significance is deplorable, the ulterior suggestion is this: that so far as Filth in any instance produces anew such a disease as erysipelas or puerperal fever on the one hand, or phthisis or other tubercular disease on the other, the mischief first done is of a sort which entails certain possibilities of extension: such, namely, that in the one instance by accidental contagion, as in the other instance by hereditary transmission, it may, for aught we know, indefinitely extend beyond the sphere in which Filth first produced it.

II.

Forms in which Filth is found producing disease:

14.—Having in the above statements explained what I believe to be the present knowledge of my profession with regard to the diseases which Filth is apt to produce in the human body brought under its influence, and with regard therefore to the exact dangers which each prevalence of Filth implies, I now turn to the more administrative aspects of the matter, and may begin by referring to the chief forms in which Filth is apt to be about us.

Filth operating where it stands:

15.—There are houses, there are groups of houses, there are whole villages, there are considerable sections of towns, there are even entire and not small towns, where general slovenliness in everything which relates to the removal of refuse-matter, slovenliness which in very many cases amounts to utter bestiality of neglect, is the local habit: where, within or just outside each house, or in spaces common to many houses, lies for an indefinite time, undergoing fœtid decomposition, more or less of the putrefiable refuse which house-life, and some sorts of trade-life, produce: excrement of man and brute, and garbage of all sorts, and ponded slop-waters: sometimes lying bare on the common surface; sometimes unintentionally stored out of sight and recollection in drains or sewers which cannot carry them away; sometimes held in receptacles specially provided to favor accumulation, as privy-pits and other cesspools for excrement and slop-water, and so-called dust-bins receiving kitchen-refuse and other filth. And with this state of things, be it on large or on small scale, two chief sorts of danger to life arise: one, that volatile effluvia from the refuse pollute the surrounding air and everything which it contains; the other, that the liquid parts of the refuse pass by soakage or leakage into the surrounding soil, to mingle there of course in whatever water the soil yields, and in certain cases thus to occasion the deadliest pollution of wells and springs. To a really immense

* See in Sixth Report to the Privy Council, pp. 58-64, observations on the so-called "traumatic infections" in their relations to Hospital Hygiene.

extent, to an extent indeed which persons unpractised in sanitary inspection could scarcely find themselves able to imagine, dangers of these two sorts are prevailing throughout the length and breadth of this country, not only in their slighter degrees, but in degrees which are gross and scandalous and very often, I repeat, truly bestial. And I state all this in unequivocal language, because I feel that, if the new sanitary organisation of the country is to fulfil its purpose, the administrators, local and central, must begin by fully recognising the real state of the case, and with consciousness that in many instances they will have to introduce for the first time, as into savage life, the rudiments of sanitary civilisation.

Filth operating at a distance.

16.—A second point, which equally with the above needs to be recognised by all who are responsible for the prevention of Filth-Diseases, is: that Filth does not only infect where it stands, but can transmit its infective power afar by certain appropriate channels of conveyance; that, for instance, houses which have unguarded drainage-communication with cesspools or sewers may receive through such communication the same filth-infections as if excrement stood rotting within their walls; and that public or private water-reservoirs or water-conduits, giving accidental admission to filth, will carry the infection of the filth whithersoever their outflow reaches. Thus it has again and again happened that an individual house, with every apparent cleanliness and luxury, has received the contagium of enteric fever through some one unguarded drain-inlet; or that numbers of such houses have simultaneously received the infection, as an epidemic, in places where the drain-inlets in general have been subject to undue air-pressure from within the sewer. And thus equally on the other hand it has again and again happened that households, while themselves without sanitary reproach, have received the contagium of enteric fever through some nastiness affecting (perhaps at a considerable distance) the common water-supply of the district in which they are.*

Chief sources of excremental infection illustrated.

17.—When an epidemic of enteric fever, or of cholera or diarrhœa, has been traced (as in general it quite easily can be) to some gross excremental pollution of air or water, the primary source of such pollution will usually be under one or more of the following three heads, viz.—faults of public sewerage, faults of indoor water-closets and other apparatus of house-drainage, and the fault of bog-privies.

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* For illustrations how the infection of houses with Filth-diseases (and specially with enteric fever) is promoted by imperfect ventilation of sewers, I may refer to the case of Windsor, which I gave in my first Annual Report to the Privy Council, p. 16, or to the cases of Croydon and Worthing which Dr. Buchanan describes in appendix to my Ninth Report, pp. 103 and 195: and of course these illustrations of infection on an epidemic scale would apply à fortiori to individual cases where the drain-inlets of houses are left untrapped. To illustrate the relations of polluted public water-supplies to the dissemination of cholera and enteric fever, I may refer to the collection of cases which I gave in my Twelfth Report.

18.—The public sewerage may be at fault in either of two ways: first, in absence of sewers, so that slop-waters and other liquid filth, if not disposed of on the private premises, have to pass without proper tubular conveyance along public ways, either free on the general surface, or in open and generally very irregular channels meant only for rain-water, where necessarily they must more or less stagnate and stink and soak: secondly, in the existence of sewers which in themselves are more or less mischievous.

(1.) In regard of sewerage;

With regard to non-provision of sewers in inhabited areas, apparently there often is an assumption that sewers may properly be dispensed with in cases where water-closets are not in use; that sewers (*i.e.* public drains of tubular type) are only wanted where the intention is to convey privy-refuse; and that, for the mere slop-waters of the population, the open way-side gutters which are meant for rain-water will suffice. This assumption can only rest on ignorance of what "slop-waters" really are, in respect of the filth which is contained in them; and its wrongness is sufficiently evident to anyone who observes how extremely offensive are in general such wayside gutters as are allowed to receive liquid refuse from groups of houses. Such refuse at its worst is a very condensed form of sewage, and even at its best is such as cannot without nuisance be let loiter and soak by the way-side. As soon as the point is passed at which houses can be expected to dispose of their own liquid refuse on their own ground, the point is reached at which proper public channels for the conveyance of such refuse should be provided; and the irregular way-side channels which may perhaps quite properly suffice for rain-fall, cannot, I apprehend, in relation to slop-waters, be deemed such "sufficient sewers" as the law requiries local authorities to provide.

(*a.*) want of sewers;

Demerits in existing sewers can in some essential respects be judged by common observation. As the object of a sewer's existence is to prevent the stagnation of filth in and about houses and frequented places, and to guard against the dangerous pollution of air and soil which the filth, if not effectually conveyed away, must occasion, so, of course, any sewer which itself occasions any such stagnation and pollution is (in proportion as it does so) unsuccessful; and a sewer which stinks at its open gratings is, pro tanto, giving evidence of such unsuccess. The indispensable conditions of success in a sewer are, first that the flow of sewage to its outfall shall be, as perfectly as possible, continuous and complete and scouring, not ponded and leaking and depositing; and secondly, that the sewer shall have perfect ventilation. A sewer in which these conditions are fulfilled will scarcely, if at all, under ordinary circumstances, cause appreciable odor at open (untrapped) gullies in the street; the air in it, if at times compressed, will not easily exert at the duly guarded inlets of house-drains any such pressure as can make way for it into houses; and in cases where accidental defects of house-drains unfortunately permit sewer-air to enter houses, the sewer-air will be at its lowest degree of dangerousness. It is a great security for such perfect

(*b.*) faults in sewers;

ventilation of sewers as is essential to the safety of houses, that, in addition to whatever special ventilating-shafts are provided, street-gullies should as far as practicable be left untrapped: and complaint of nuisance from any such gullies should not necessarily be taken as reason for trapping them. In case of such complaint, the presumption is that from original ill-construction or some other cause the sewer does not properly fulfil its object, but has filth accumulated and stagnant in it as in a cesspool, and has its ventilation at least relatively in defect; and the nuisance which such a sewer occasions in the public way, is far less important than the risk incurred by the inhabitants of houses which drain into the sewer. Merely to trap street-gullies in any such case would be greatly to increase the danger to houses; the use of charcoal trays in gullies, in the hope to disinfect their effluvia, has repeatedly proved dangerous in the same way: and I accordingly think it an essential principle, that the evil of a stinking sewer should always be dealt with at its root. Thus, a sewer which is imperfectly ventilated should have perfect ventilation provided for it; a sewer which, though fairly constructed, is from poorness of current not completely self-scouring, should at due intervals have extrinsic flushing: and sewers which, with radical ill-construction, are virtually but cesspools under the street, should without delay be abolished.

(2.) in regard of house-drainage and water-closets;

19.—Secondly, a very large danger to the public health, and particularly to the better-off classes of society, has of late years consisted in the recklessness with which house-drains, receiving pipes from water-closets, sinks, cisterns, baths, &c., in the interior of houses, and often actually within bedrooms or the adjoining dressing-rooms, have been brought into communication with sewers. Among architects and builders there seems to have been very imperfect recognition of the danger which this arrangement must involve, in event either of unskilful first construction or of subsequent mismanagement or want of repair. Then, in regard of construction, an almost unlimited trust has been placed in artisans who not only could hardly be expected to understand certain of the finer conditions (as to atmospheric pressure) which they had to meet, but who also in not a few instances have evidently failed to apprehend that even their mechanical work requires conscientious execution. Under influence of the latter deficiency there have been left in innumerable cases all sorts of escape-holes for sewer-effluvia into houses, and disjointed drains effusing their filth into basements: while under the other deficiency, house-drainage, though done with good workmanlike intention, has often, for want of skilled guidance, been left entirely without exterior ventilation, and sometimes has in addition had the over-flow pipes of baths or cisterns acting as sewer-ventilators into the house: and all this not infrequently in places where the sewer itself, from which so much air has been invited, has been an ill-conditioned and unventilated sort of cesspool. It is almost superfluous to say that under circumstances of

his sort a large quantity of enteric fever has been ensured; and I should suppose that also a very large quantity of other filth-disease must have sprung from the same cause. Then there has been the vast quantity of interior air-fouling which arises from mismanagement of drain-inlets, or from non-repair of worn-out apparatus: as when sink-traps, injudiciously made moveable, have been set aside; or when pipes under temporary disuse, having evaporated all water from their traps, or leaden closet-pipes, with holes corroded in them, have been left fouling the house with a continuous eructation of sewer-air.* Again, in poor neighbourhoods, water-closets have in many cases been constructed with scanty and ill-arranged water-service to flush them, or have even been left to only such flushing as the slop-water of the house, or other water thrown in by hand, might give: and again and again these ill-watered and often obstructed closets have been found acting on a large scale as causes of disease. Again, a different sort of danger, and one which seems capable of wide operation, has been seen to arise where water-closets receive their flushing-service from the mains of a so-called "constant" supply: for supplies called constant must not only sometimes intermit for purposes of necessary repair, but also in some cases are habitually cut off during the hours of night; and the danger is that, during times of intermission, if there be not service-boxes or cisterns between the privy-taps and the mains, privy-effluvia and even in some cases fluid filth will be (so to speak) sucked from closet-pans into water-pipes. This danger, which hitherto has been little known to the public, but which it is important to have well understood, is illustrated by two remarkable reports which I subjoin, respectively by Dr. Blaxall and Dr. Buchanan, on outbreaks of enteric fever thus occasioned. Dr. Blaxall's report (App. No. 2) is of particular interest, as it represents, I believe, our first departmental discovery of this cause of disease in actual operation; † and Dr. Buchanan's (App. No. 3) seems to me of remarkable value, not only as being in itself a model of exact ætiological inquiry, but as illustrating the filth-causation of enteric fever, clandestinely effected, under circumstances where primâ facie any filth-disease would have seemed impossible.

(3.) in regard of accumulative privies.

20.—Thirdly, while it cannot be denied that ill-devised and ill-managed water-closets and their accompaniments have caused (and particularly among the better-off classes of society) filth-diseases to a very large extent, a far larger range of mischief throughout

* Dr. Andrew Fergus of Glasgow in papers of much sanitary interest contributed by him to the Edinburgh Medical Journal (February 1872 and February 1874) adduces evidence to show that the ordinary corrosion of leaden pipes from closets and sinks is a chemical effect of sewer-air, and that it goes on with greatly increased rapidity in cases where the pipes are unventilated.

† I am glad to note, as corroboration from a source which I highly esteem, that, while Dr. Blaxall was recording the observations which he had made at Sherborne in evidence of the above mode of production of enteric fever, Dr. Alfred Carpenter of Croydon was recording independent observations which he had made in that town to the same effect. See "Public Health," July, 1873.

England has attached to the other kinds of privy-arrangement: and of all the filth-influences which prevail against human life in this country, privies of the accumulative sort operate undoubtedly to far the largest extent.

By what standard should they be judged?

The intention and, where realised, the distinctive merit of a system of water-closets is, that in removing excremental matters from a house it does so with perfect promptitude, and in a perfectly neat and complete manner, not having any intervals of delay, nor leaving any residue of filth, nor diffusing any during its operation; and where the water-system is not in use, these objects ought still as far as possible to be secured. Thus, in the absence of water-closets, evidently any reasonable alternative system ought to include the following two factors, brought into thoroughly good mutual adjustment: first, proper catchment-apparatus in privies; and secondly, proper arrangements for privy-scavenage. The essential conditions of a proper catchment-apparatus are that it, as well as all adjacent underworks of the privy, shall as far as practicable be unabsorbent; that it shall absolutely preclude soakage or leakage of filth into soil or buildings or water; that it shall not admit rainfall or slop-waters; that it shall be so limited in size as not to allow of any needlessly offensive accumulations of matter; and that, whether moveable or fixed, it shall easily admit of thorough cleansing. The essential conditions of proper privy-scavenging are, that it shall be strictly methodical; that from beginning to end it shall be so conducted as to occasion the least possible nuisance, public or private; that its performance shall be at such short intervals as invariably to precede the putrefaction of the excrement; and that there shall be associated with it all such acts of thorough cleansing as the catchment-apparatus and other underworks of the privies may require. Further, in order that the fulfilment of these conditions may be possible, it is essential that the location and approaches of the privy should be definitely adapted to acts of scavenage.

Their actual relation to that standard.

Now, hitherto, in places not having water-closets, the general practice has flagrantly contravened those conditions. Either it has had no other catchment-apparatus than the bare earth beneath the privy-seat, and has trusted that this (receiving the excrements and often also the house-slops on to its natural surface or into a hole dug into it) would absorb and drain away the fluid filth, and serve during months and years as heaping-place for the remainder; or else it has had, as supplement to the privy, a large enclosed midden-stead or cesspool, partly or entirely of brickwork or masonry, intended to retain large accumulations of at least the solid filth, with or without the ashes and other dry refuse of the house, and in general dividing its fluid between an escape-channel, specially provided, and such soakage and leakage in other directions as the construction has undesignedly or designedly almost always permitted. Privies, such as these, have not been meant to have their filth removed except when its mere largeness of bulk (exceeding or threatening to exceed the limits of the privy-pit or cesspool or midden) might mechanically make

removal necessary, or else when there might happen to arise an agricultural opportunity for the stuff; and public scavenging in relation to such privies has either had no existence, or has been adapted to the supposition of an indefinite local tolerance of accumulation. All this accumulation, with its attendant exhalation and soakage, and at intervals the shovelling and carting away of its masses of fœtid refuse, and the exposure of the filth-sodden catchment-surfaces of privy-pits and middens, has been, as needs hardly be said, an extreme nuisance to those in whose vicinity it has been; and sometimes with the aggravating condition that, because of the situation of the privy, each filth-removal must be through the inhabited house. What nuisance this system at present constitutes in innumerable populous places, including some of our largest towns, can indeed hardly be conceived by persons who do not know it in operation; and the infective pollutions of air and water-supply, which it occasions to an immense extent in towns and villages throughout the country, are chief means of spreading in such places some of the most fatal of filth-diseases.

Excremental infection which has caused disease may require careful search to expose it:

21.—Such are the three heads, under one or more of which will commonly be found the true explanation of outbreaks and prevalences of entero-zymotic disease in the different districts of this country; and outbreaks which from time to time have arisen in seeming dissociation from such causes as I describe have again and again, under minute examination, resolved themselves into new illustrations of the general rule. For administrative reasons it is highly important that cases which seem exceptional should be thoroughly studied; and especially as regards enteric fever (because it apparently obeys so very sharply defined a rule of causation) I would advocate the strictest scrutiny of any origination which may seem not to have been excremental. Present knowledge seems very positively to say that the degree and extent in which enteric fever shall remain unexterminated from England will express the degree and extent in which sanitary administration shall have failed in rudimentary duties; and since, in particular local applications of this test, the prevalence of enteric fever in any district will primâ facie impugn the sufficiency of the local administration, it becomes of the more importance that the habits of the disease should be well understood, and that every mystification of unexplained facts should as far as possible be removed. An unexplained outbreak of enteric fever will sometimes mean (as in the very instructive case reported in my App. No. 5.) that the locality where the disease occurs has had in it, as its own local property, some curiously unsuspected liability to filth-infection: but on the other hand there are circumstances under which the excremental nuisance of one district may exceptionally do its mischief in another. This possibility might of course be illustrated by any such conductions of filth as I have noted in a former passage of these observations; but I wish here to draw particular attention to the possibility, now well-established, of filth-infection being transmitted even on a large scale from district

as in case reported in App. No. 5;

and in various epidemics produced by infected milk supply.

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to district in particular articles of food, and especially in the article of milk. In 1870, Dr. Ballard, now of this Department, but who at that time was working with high character as Officer of Health for the parish of Islington, was able to shew that an outbreak of enteric fever, which had attacked in ten weeks 70 families and 175 persons in part of his district, coincided with the use of milk supplied from a particular dairy, where shortly before the outbreak there had been cases of enteric fever, and where apparently the infected house-drainage must have had easy access to an underground water-tank on the premises. There could be little reasonable doubt as to what in this epidemic had been the infectant ; and since Dr. Ballard's connexion with this Department it has twice happened to him to be able very clearly to trace the same method of infection at work in considerable outbreaks of enteric fever which he has been investigating; one in 1872 at Armley in the borough of Leeds, the other in 1873 at Moseley and Balsall Heath near Birmingham. A like case on a very large scale, and in some respects of unique interest, occurred also last year in London, chiefly in and about Marylebone, and was investigated elaborately by Mr. Netten Radcliffe, assisted in some stages of the inquiry by Mr. Power. A special interest of this case, as regards the point to which I have been adverting, is that here a great outbreak of enteric fever occurred at a distance of forty or fifty miles from the sanitary jurisdiction in which its true cause was contained ; and the case is of the more value because the outbreak, as it happened to be in London, and happened also to have struck at its first blow in the houses of more than a dozen physicians and surgeons, had from the first its circumstances very attentively noticed by an unusual number of competent observers deeply interested in a right knowledge of them. I subjoin (App. Nos. 4–6) the instructive reports which relate to these three epidemics of enteric fever, respectively referable to supplies of milk. There is in each case every reason to believe that the epidemic was due to excremental pollution of the dairyman's well; and it is solely in that point of view that I here insist on the cases. How the dairyman's water was enabled to spread its influence to his milk, and by what proportionate admixture it did so, are questions of little importance to my present subject-matter. The essential point is, that the water with which a dairyman washes his pails, and of which a very variable quantity may under varying circumstances remain in them as an addition to his milk, is not likely to be of better quality than that which he and his local sanitary authority consider good enough for his own drinking; and that, in regard of this and many like possibilities of casual filth-infection, the general public are in intimate sanitary partnership with various of their purveyors of food.

III.

To prevent Filth-Diseases, Filth must be prevented.

22. In order to the prevention of Filth-Diseases, the prevention of Filth is indispensable. Truism though this may seem, I think

Disinfectants can only give a very subordinate assistance.

it needs to be expressly insisted on, as against any belief that districts, allowed to become filthy, can off-hand be made wholesome by disinfectants. To chemically disinfect (in the true sense of that word) the filth of any neglected district, to follow the body and branchings of the filth with really effective chemical treatment, to thoroughly destroy or counteract it in muck-heaps and cesspools, and ashpits, and sewers, and drains, and where soaking into wells, and where exhaling into houses, cannot, I apprehend, be proposed as physically possible; and the utmost which disinfection can do in this sense is apparently not likely to be more than in a certain class of cases (see § 39) to contribute something collateral and supplementary to efforts which mainly must be of the other sort. This opinion, as to the very limited degree in which chemistry can prevail against arrears of uncleanliness, does not at all discredit the appeals which are constantly and very properly made to chemistry for help in a quite different sphere of operation; with regard, namely, to the management of individual cases of infectious disease, and to the immediate disinfection of everything which comes from them.* In this latter use of disinfectants, everything turns on the accuracy and completeness with which each prescribed performance is done; but such accuracy and completeness are of course only to be ensured where operations are within well-defined and narrow limits; and in proportion as disinfection pretends to work on indefinite quantities or in indefinite spaces, it ceases to have that practical meaning. Again and again in the experience of this department a district has been found under some terrible visitation of enteric fever, from filth-infection operating through house drains or water-supply; but with the local authority inactive as to the true cause of the mischief, and only bent on practising about the place, under name of disinfection, some futile ceremony of vague chemical libations or powderings. Conduct such as this, referring apparently rather to some mythical "epidemic influence" than to the known causes of disease, and savouring rather of superstitious observance than of rational recourse to chemistry, is

* As regards certain procedures on a small scale, we know that, with well-circumscribed matter to work upon, and with chemical action precisely adjusted to its task, we can absolutely kill any given contagium. Taking, for instance, a bit of glass which has on it a charge of vaccine or variolous matter, we know that, if we *sufficiently* heat it in the flame of a lamp, or *sufficiently* treat it with certain strong officinal chemicals which act in a like manner, we annihilate the power of infection; and we know that, in the sick-room where lies a patient with any dangerous infectious disease—say diphtheria, small-pox, or enteric fever, we can to some extent imitate the above acts. Provided that real skill shall direct, and real conscientiousness shall execute, what has to be done, every tangible discharge which passes from the patient, every sheet or towel or handkerchief which any discharge from him has fouled, can be treated with heat or other disinfectant in a way to give at least comparative security against any outward spreading of his infection. It is greatly to be hoped that, with time and with progress of general education, the systematic doing of such acts as these will in each sick-house be considered an imperative duty of good citizenship, and may at last be so fully understood in that light as to be made, as far as practicable, an obligation at law: for disinfection in that sense (however remote we may now be from any sufficient adoption of it) would undoubtedly, if adopted, make chemistry an important ally to cleanliness in combating the filth-diseases of England; but such disinfection, the whole value of which is in its precision, differs diametrically from the pretended district-disinfections to which my text refers.

eminently not that by which filth-diseases can be prevented; and, contrasting it therefore with means by which that result can be secured, I would here specially note a warning against it.

The essential preventive is cleanliness;

23.—In order to reduce that vast quantity of preventable disease which has its type in enteric fever, and in relation to which each individual case of enteric fever which occurs ought to be regarded as having an important local significance, the one essential condition is CLEANLINESS. That local sanitary authorities, proceeding to act upon this principle, with a clear intelligence of what cleanliness really means, and with sincere resolution to enforce it in their respective districts, can within a few years reduce by some tens of thousands the annual mortality of England, is, I think, at least as certain as that such ought to be the aim of their existence.

in the highest degree in which it can be attained.

24.—The perfection of cleanliness would be that all refuse-matters should from their very beginning pass away inoffensively and continuously: and the principles of approximation to that ideal must evidently be, first to provide to the largest practicable extent for the continuous outflow of refuse as fast as produced, and secondly (so far as continuous outflow cannot be got) to provide for the closest possible limitation and the completest possible innocuousness of such refuse as is unavoidably detained. Rules like these present themselves as mere transcripts from Nature to those who know as physiologists how the animal body, in its individual working, deals with the refuse of its own vital actions: and the individual body, hindered in its respiration or other excretory acts, may serve to picture the inevitable unhealthiness of any community, whether large or small, which lets its decaying refuse-matters gather about it.

Cleanliness not possible for communities, except with method and organization for certain collective services.

25.—Wherever human beings are settled for residence, the cleanliness which is indispensable for healthy life can only be secured by strict method. Even where houses stand single and with wide space around them, the householder cannot safely neglect that sanitary obligation in regard of the refuse of his one household: the slop-waters, the cooking-waste, the various house-sweepings, the human fæces and urine, the excrements of domestic animals, &c.: and the obligation becomes more and more important in proportion as dwellings are gathered together on comparatively small areas.

The law does not allow any holder of premises, whether in town or country, to neglect that obligation to any injurious extent; and it is the express intention of the law that each local Sanitary Authority, rural or urban, should in its respective district see strictly to the enforcement of the obligation, and give all proper aid to its due fulfilment. Each Authority is bound by law to see that the drains, waterclosets, privies, and ash-pits in its district are so constructed and kept as not to be a nuisance: and with reference to these and various other matters of concern to health, each Authority is bound by law to make from time to time (either by itself or its officers) inspection of its district for the purpose of ascertaining what

nuisances exist calling for abatement under the provisions of the Nuisances Removal Act, and the Authority must enforce those provisions against the nuisances. In order that residents may have necessary common facilities for disposing of their refuse, the Authorities are bound by law to make such sewers as may be necessary for effectually cleansing and draining their districts: and they may either themselves undertake or contract for the removal of refuse from premises and the cleansing of privies, ashpits, and cesspools, or may make bye-laws imposing these duties upon the occupiers of the premises.

In the detailed application of the law different districts and parts of districts require, at the hands of their Authorities, a management graduated according to circumstances: certain circumstances requiring only the general supervision of the Authority, while others require, in higher and higher degrees, that the Authority should itself intervene and operate. The holder of outlying rural premises, will generally be able to consume his own refuse-matters satisfactorily on his own or some closely adjacent land: and the sanitary Authority, in regard of such cases, has only to make sure that the essential objects of the Nuisances Removal law are attained. Even here, however, it will always be requisite to see, as regards labourers' cottages and other like cases, that refuse is not thrown or accumulated in situations where its effluvia or soakings can be offensive or injurious; and the relation of privies, piggeries, cattle-stalls and dung-heaps, and of their several outflows, to the walls of dwellings and to sources of water-supply, must always be cautiously observed. In proportion as dwellings are aggregated, and populations increase, in villages, towns, and cities, it becomes more and more difficult for refuse to be properly disposed of by the separate action of individual householders. In very early stages of such aggregation, the Authority finds itself called upon to provide common sewers for the joint liquid refuse of the localities, and more or less common scavenging, not only for the public ways but in aid of the defæcation of private premises; and these collective services require to be more and more developed in proportion as populations become more and more urban. In proportion as such facilities are not given, more and more vigilance is wanted under §20 of the Sanitary Act, 1866, to see that nuisance do not arise from individual mismanagement of house-refuse,—that, in places unprovided with sewers nuisance be not caused by slop-water,—that, in places where water-closets are impossible, nuisance from bad privy-management do not exist,—that, in places to which scavenging does not extend, nuisance from filth-accumulation do not arise on individual premises. On the other hand, with the growth of the collective services, the Authority more and more finds that (greatly to the advantage of the public health) it has become the preventer rather than the remover of nuisances; and so universally is this the fact that, bearing it in mind, Sanitary Authorities, when proceeding to think systematically of their duties, will generally find it advantageous to regard the prevention rather than the removal of nuisances as their main administrative problem.

Removal of refuse has two main divisions: sewerage and scavenage.

26. Sewerage and scavenage between them have to do all the work of each Local Authority in carrying off the refuse of the district: the privy-refuse, the ashpit-refuse, the slop-waters, and in certain cases trade-refuse and the refuse of domestic animals. Sewerage and scavenage—assisted, as regards the matters which are within their range, by proper bye-laws, and supplemented, as regards the matters which are outside their range, by proper enforcement of the law against nuisances,—they, thus assisted and supplemented, and of course with adequate supply of water, are the two essential agencies of all local cleanliness. In proceeding to settle any scheme for their local application, the question first to be decided is, which of the two is to deal with privy-refuse; but whichever way this decision is to go, a clear view must always be had as to the eventual disposal of both sorts of refuse.

All disposal of refuse-matters must be so managed as not to make nuisance.

27.—All Local Authorities collecting refuse-matters, whether by sewerage or by scavenging, have of course to dispose of them in ways which shall not cause, or shall cause as little as possible, any nuisance in relation either to air or water: and this (sometimes difficult) obligation is at present urging itself on the notice of many Local Authorities as virtually a new problem with regard to the outfalls of liquid refuse. The obligation, not to cause nuisance by sewage outfalls, exists in an infinite range of magnitudes: from the vast sewage-tunnels of London on the one hand to the little village-sewer and its occasional flushings on the other; but, whether as to village slop-waters or to great urban sewage-floods, equally it has to be provided that no avoidable atmospheric nuisance shall be produced by the outfall, and that all natural water-courses (or at least all such as may be giving domestic supplies) shall be protected as far as practicable from pollution. Along the coast-line of England there may be cases in which those conditions will be most conveniently and cheaply attained by letting the sewage run as mere waste (subject to such precautions and with such engineering arrangements as may be necessary) into river-estuaries or into the sea: but this course, in the cases where it is possible, is not by any means necessarily to be preferred: for sewage contains the essential elements of fertilisation for land, and land ought always to be considered its proper destination except where from particular local circumstances this use of it would involve too much cost to be profitable. In the large majority of cases throughout England an option of entirely wasting sewage as above does not exist: on the contrary, the obligation not to cause nuisance by sewage-outfalls will be found in general to involve as its consequence that the sewage must be purified by land; which generally will in return by increased fertility yield more or less pecuniary set-off against the cost of such constructions and service as the use of that method of sewage-disinfection may require. Evidently, then, the management of sewage-outfalls is a matter for serious consideration by Local Authorities: so that on the one hand each inhabited area may best eliminate every sort of fluid refuse

which it produces, and that, on the other hand, the required prevention of outfall-nuisances may be economically as well as effectually attained. To improve public knowledge on the means of attaining those objects has for many past years been the object of continuous elaborate study under successive Royal Commissions; and it is to be desired that all persons who have to deal responsibly with the disposal of refuse-matters should be acquainted with the practical conclusions to which that study has led, as particularly represented in the very valuable reports of the Rivers Pollution Commission, 1868.

Disinfection of sewage.

28.—As regards means for disinfecting sewage the Commission reports that purification in such degree that the outflow may properly be allowed to pass into the running waters of the country, can be got under certain conditions by the action of land upon the sewage, but not in any other practicable way; and that, in order to the required action of land on sewage, two methods are available: the method by *agricultural irrigation* and the method by *intermittent filtration.*

Of these two methods neither can in practice be so applied as not to include some participation of the other: for filtering beds have of course more or less irrigated surface, and irrigated fields have of course more or less downward filtration: but, except so far as there is this accidental overlapping, the methods contrast with each other in respect of the natural forces to which they chiefly appeal; and, while they both effect the purification of sewage, their collateral results are widely different. The irrigation-method bases itself on the *appropriative* action which a certain surface of cultivated land with growing crops on it exerts over organic matters supplied to it as manure: the case for it exists in proportion as there is suitable land in the comparatively large extent which suffices to utilise to the utmost the fertilising power of sewage: and the intention is that this land, while disinfecting the sewage, shall also yield adequate pecuniary return in irrigated crops. The filtration-method, on the contrary, bases itself on the *destructive* influence which a certain cubic quantity of well-aerated porous earth, receiving organic matters at intervals on its surface, and discharging them below, will exert on them as they gradually sink (followed again by air) through its thickness: it requires plots of suitably-placed porous land, deeply under-drained, to be used in rotation as disinfecting-ground for the sewage delivered on to them; and the method is such that, though more or less vegetable produce may be obtained from the comparatively small area of land which suffices for these filtration-plots, the fertilising powers of the sewage are of necessity in great part sacrificed.

In view of the sanitary intention of these processes, Local Authorities adopting either of them must, of course, see that it effects its proposed action completely, and that it does not cause any nuisance of its own. In choosing localities for irrigation or filtration, in designing the works for either purpose, and in the

day-by-day management of such works, every possible care must be taken that all populations within range of influence of the works shall be safe from injury, whether through air or through water; and as regards the latter, it must be particularly cared for that the quantity of land, and the details of the application of sewage to it, shall be such as will, under all variations of seasons and weather, always effectually purify the sewage before it can have access to any watercourse. The standard of the Rivers Pollution Commission, on the presumption that rivers are not to supply drinking-water, is, that irrigation-land at the rate of at least an acre for every 100 of the population, or filtration-land at the rate of an acre for every 3,000 of the population, will give to sewage such degree of purification as to justify its being allowed to pass into rivers; but with what least quantity of land (properly used) the purification of sewage will be so complete that the outflow of the land shall be safe drinking-water, is a question which has yet to be answered by local experiences.

Limits of the utility of sewers, as regards what must, and what may be conveyed by them.

29.—Among the conclusions of the Commission, there are two which may particularly assist the judgment of Local Authorities as to getting full use of sewerage in populous places. First, namely, with reference to the present state of the case as to excremental refuse, it appears that the ordinary sewage-problem as to the means of preventing nuisance from the outflow of populous places, is not materially lighter in places where water-closets are few or none, and where systems which purport to withhold privy-solids from the sewers are in use, than it is in places where water-closets are general. It appears that in all places of the former class the sewage has in fact under the existing arrangements universally received a very large proportion of human refuse: and that apparently the mere house-slops and street-washings of populous places (not to mention other sources of pollution) must in themselves, under any conceivable system, constitute a highly offensive outflow, requiring substantially the same treatment as the sewage into which water-closets empty. And secondly, the Commission reports that, for populous places which are also seats of manufacture, it would generally be possible, without materially complicating the sewage-problem, to allow the fluid refuse of industrial processes, with few exceptions, to pass into the sewers to be disposed of as common sewage: the special exceptions which are named being the refuse of workers in metal and of manufacturers of gas, paraffin oil, pyroligneous acid and animal charcoal: that, subject to some such exceptions as these and to proper regulations, the discharge of fluid industrial refuse into sewers would generally not render the sewage more difficult of use, and would in some cases, in respect of certain contained refuse-matters, greatly increase the agricultural value of the sewage.

Sewers and drains as means of cleanliness.

30.—Of sewers and drains, with regard to the technic of their construction, I of course do not pretend to speak. All rules applicable to this matter are given in a special Memorandum issued

by the Board for the assistance of local officers, which, as having been prepared by Mr. Rawlinson, the Board's Chief Engineering Inspector, has the authority of an unequalled experience and my reference to sewers and drains is only in regard of their sanitary results. In proportion as they are skilful or unskilful appliances, so they become powerful influences for good or for evil; and in this point of view, I would urge the necessity of such works (even though on the smallest scale) being always planned with adequate skill and executed under trustworthy supervision. In the same point of view I would also urge the importance of using as channels for liquid refuse none but properly constructed sewers and drains, and ot therefore superseding by such constructions, as soon as practicable, the many now existing mere gutters, or ditches, or rude irregular works of brick or stone, which, originally meant only for rain-water, are incapable of fulfilling in an effective, cleanly and wholesome manner, the purpose for which modern sewers are designed. This recommendation applies not only to cases where the channels receive privy-drainage, but likewise (for reasons previously explained) to cases where they receive only slop-water: and equally in both cases it must be provided that any sewer which is not completely self-scouring shall at due intervals have effective flushing. With regard to the smaller relations of the subject, as represented in the collection of village-slops, useful information will be found in an appended report by Mr. Netten Radcliffe (to which I shall hereafter more particularly refer) on means of preventing excrement-nuisances in towns and villages.

Shall water-closets be adopted?

31.—The choice between a water-closet system and a system of so-called dry-privies, is necessarily in each case a question for local judgment on grounds which in great part must be purely local.

Their advantages where certain conditions can be fulfilled;

32.—The advantages of the former where it can be adopted and will be properly worked, are—as regards the supremely important object of getting the refuse continuously and completely removed, too evident to require advocacy. Those advantages however may fail to be realised if the system be adopted without due circumspection; and the conditions which ought to be kept in view in order to avoid any such failure are apparently these three:—

first, that the closets will universally receive an unfailing sufficiency of water properly supplied to them;

secondly, that the comparatively large volume of sewage which the system produces can be in all respects satisfactorily disposed of; and,

thirdly, that on all premises which the system brings into connexion with the common sewers, the construction and keeping of the closets and other drainage-relations will be subject to skilled direction and control.

as to water-supply;

(*a.*) The water-supply of a place should not be deemed sufficient for a system of water-closets unless it be such that each ordinary water-closet can be flushed as often as it is used. If the supply

be professedly "constant" it must be really constant, subject only to the occasional short interruptions which may be necessary for repairs and the like, and against the possible dangers of which (§ 19) proper precautions must have been adopted; if, on the contrary, it be confessedly intermittent, and therefore require domestic storage of water, the supply of water (sufficient to fill all house-cisterns) should be at least once in every period of 24 hours; and in any case proper mechanical arrangements to prevent waste of water and to secure the water-pipes against entrance of privy-air will be necessary.

as to sewers;

(*b.*) In order to a satisfactory discharge of privy-sewage, properly constructed sewers, with properly located outfall, are of course indispensable: sewers which would also convey the slop-waters, and generally the rain-fall, or more or less of the rain-fall,* of their drainage-area. It may sometimes be the case that sewers already existing and in all respects satisfactorily working as provision for slop-waters and surface-drainage, are of such construction and with such outfall-arrangements as to be suited also for the addition of privy-sewage, or capable at very moderate expense of being rendered so: for as slop-waters partake (in greater or less degree) of the offensive qualities of privy-sewage, sewers which are to convey them require the same sort of care as to construction and outfall-arrangements as if privy-sewage were also to be conveyed. If existing slop-water sewers are offensive or inefficient in the service in which they already act, or if their outfall is such as already to cause nuisance or water-pollution, evidently no such additional service as the conveyance of privy-sewage can be claimed of them in their actual state: but in this class of cases (and according to the degree of offence or inefficiency) the local sewerage would be judged to require reform, even apart from any question of water-closets; and in connexion with any such reform, especially in towns which have or ought to have common waterworks, there will be favorable opportunity for considering whether a system of water-closets should be adopted.

as to communications;

(*c.*) No premises ought, either through water-closets or in any other way, to be brought into drainage-connexion with common sewers unless they can be made reasonably secure against the dangers of sewage-infection. Part of such security would consist in the fact of the sewers themselves being such and in such state as they should be, especially with regard to scouring and ventilation: but a further, very essential, part would depend on the proper situation, construction, and keeping of the drains and drain-inlets of individual premises. In this latter respect, the following conditions ought to be insisted on:—

that every private drain be properly trapped and ventilated in relation to the common sewer, and be itself also properly constructed;

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* In some districts special arrangements for the discharge of storm-waters may be necessary; and in some it may be desired to effect as far as practicable a diversion of all clean rainfall from the sewers: but the consideration of questions of this sort will be special to the localities where they arise.

that every private drain having inlets within a house, have ascending from its head or heads into some suitable high position in the open air, and where it cannot infect the interior, a ventilating-pipe or ventilating-pipes of sectional area amply proportionate to its own;

that all slop-water pipes from within houses be provided at their sinks or other inlets with fixed traps, but further, that, as far as practicable, they be separate from privy-pipes, and made to and open over trapped drain-gratings outside the house, not direct into privy-pipes or drains;

that no overflow-pipe from any cistern which furnishes domestic tap-water, nor from any cistern inside a house, be allowed to open directly into any drain or privy-pipe, but be made (as above) to end open in the outer air;

that in cases where water-closets are supplied on a "constant" system, and where generally there will not be storage-cisterns, the entrance of privy-air into water-pipes be prevented by the adaptation of special service-boxes (which also will act as waste-preventers) to all such privies as have not cisterns.

as to users;

(*d.*) In considering the admissibility of water-closets, it has always to be remembered that the working of an ordinary water-closet is easily deranged, and that water-closets, when out of order, and especially if in the interior of houses, are apt to become very dangerous nuisances. The ordinary water-closet is therefore a thoroughly ineligible form of privy for those who are unlikely to take proper care of it, or are from poverty unable to give it such occasional repairs as it may require.

as to location.

(*e.*) Among such classes of population it is of course unfit that any form of in-door privy should ever be sanctioned: but even in the best-ordered houses the occasional danger of in-door water-closets must not be disregarded. Water-closets ought never to stand where they cannot have outside windows: they ought if possible to stand as projections from the body of the house, and with windowed lobbies dividing them from it.

Where water-closets not to be adopted, what are the best alternatives for cleanliness?

33.—It must be assumed that, even in large towns, Authorities, exercising their discretion on skilled advice given to them, will sometimes pronounce against the local adoption of a system of water-closets; and even if it be assumed that the number of such cases will eventually be small, yet, at least for the present, great importance attaches to the question of other means by which privy-nuisances in large towns can be prevented. And it is the more necessary that all such means should be well understood and as far as possible perfected, because permanently it must at any rate be the lot of many small towns and of most villages to depend on them rather than on water-closets.

In a former section of these observations I described at some length the extremely filthy and dangerous arrangements which frequently, or I fear I should say generally, exist in places where water-closets are not in use. Modern experience, however, has shown, and the fact is of the highest sanitary importance, that

such arrangements are not the necessary alternative to a system of water-closets; but that, failing a water-system, both large and small populations can obtain under other and amended systems of privy-management a complete or comparatively complete freedom from excremental nuisance and injury.

Former and present departmental nquiries.

Evidence to that effect was given five years ago in two most valuable papers which I had the honor of submitting to my Lords of the Council as appendices to my 12th Annual Report: one by Dr. Buchanan on the earth-closet system, the other conjointly by him and Mr. Netten Radcliffe on the privy-systems of various northern towns; and from that time till the present the information collected in these two reports has been the basis of all advice which I have given in the matter to which they relate. Recently, under the Local Government Board, the present state of experience in the same important branch of nuisance-prevention has been made matter of new and large investigation by Mr. Netten Radcliffe; and I have the honor of submitting to you (App. No. 7) his comprehensive and thoroughly practical report on the subject.

Mr. Netten Radcliffe's present report.

34.—The improved systems which Mr. Netten Radcliffe describes start universally with abolishing all such filthy catchment-provisions as I have referred to, and then, in order to meet the sanitary requirements, provide more or less as follows:

Pail-Privies: having as their aim that excremental matter, unaltered, shall be removed from the privies at so short intervals as not to have become offensive; and adopting as means to this end the use of moveable receptacles, which systematically at short intervals are to be changed, clean for dirty by the scavenger; and which, for the prevention of nuisance in this process have close-fitting air-tight lids to be applied to the foul pails under removal.

Ash-Privies: wherein the professed purpose of the north-country midden (to deodorise excrement by covering it with dry house-refuse) is, under strict precautionary conditions, accepted; the intention being, that the space beneath the privy-seat (but no further space) should be converted by careful masonry into a non-porous catchment-chamber, planned in slope and otherwise with particular reference to ease and frequency of systematic scavenging, and necessarily of but small size; and into which chamber, and direct upon the excrement, the ashes of the house are to be thrown, either down the hole of the seat, or with the seat hinged and lifting for the purpose, or otherwise.

Earth-Privies: as introduced by the Rev. H. Moule: purporting to effect under strictly defined conditions such applications of earth to excrement as shall render the latter inoffensive, forming with it a manure which not only can without offence be stored where it is produced, but can also, after being stored and dried, be

used in the privy again and again with the same effect as new earth, and with some progressive increase of manurial value.

Charcoal-Privies: intended to utilise, on the general plan of earth-privies, the still higher disinfectant powers of charcoal, and thus to reduce to a minimum the quantity of disinfectant required: and purporting to have the further advantage that the excrements themselves can be made contributory to the supply of the charcoal.

In certain cases, Local Authorities have special responsibilities as to privies, viz.:

35.—With general reference to the duty of filth-prevention in inhabited areas, it is necessary to observe that the actual management of privies tends to become a function of Local Authorities, first, in proportion as dry privies of any kind are in use in their districts, and, secondly, in proportion as the districts contain dense settlements of ignorant and dirty population.

where dry privies are in use;

(*a.*) The dry systems, if they are to be generally available in any populous district, must always be vigilantly superintended, or in most cases actually managed, by the Local Authority, and must be managed with forethought and competent skill. The Authority must in the first place decide as to the type of construction to which it will require householders to conform in regard of the placing of privies, and in regard of the plan of their privy-fixtures: not allowing privies to be so placed that the use of them will be a nuisance to houses or will make the privy-scavenage needlessly difficult or offensive, and carefully regulating the plan of the privy-fixtures (whether for earth-privy, charcoal-privy, pail-privy, or ash-privy) in the ways best calculated to prevent nuisance and facilitate scavenging. If the earth-system be adopted the Authority must prepare and supply the earth; if the pail-system be adopted, the Authority must supply the pails; and whether earth-system, pail-system, or ash-system, be adopted, the Authority must (except in individual cases) scavenge the privies and dispose of the refuse which is removed. Pail-privies and ash-privies in towns should be scavenged as far as practicable daily, and even where the population is least dense, at intervals not exceeding a week. Whether the Authority in acting as above shall act through its own officers and servants or through contractors will be a matter of local discretion; but, so far as it acts through contractors, it must of course see strictly to the execution of the contract, and in all cases it will have to make such bye-laws as are wanted to give effect to its system.

and where poor populations are thickly aggregated.

(*b.*) Sometimes even in country districts, but with more and more frequency in proportion as districts are urban and populous, particular poor neighbourhoods require that their privy-accommodation, whatever be its sort, should be specially cared for, and sometimes (which must be under urban powers) actually provided by the Authority.

Construction of privies for large joint use by lowest class

(*c.*) Though ordinary water-closets (and particularly within doors) are not proper for the use of dirty and ignorant populations, water-closets, specially constructed with regard to such classes of

population, and managed or constantly superintended by the Local Authority, seem the best of all yet discovered privy-contrivances for the uncivilised quarters of towns: and in this respect the experience of Liverpool deserves attention, as shewing that freedom from privy-nuisances can be attained in even the lowest of urban quarters on condition that a proper system of trough water-closets is managed by an efficient Local Authority.

and the supervision of such privies.

(*d.*) Whenever privies of any kind are used in common by many families, or are for general public use, it is essential that the Local Authority should have them under constant supervision, and that (whether they are or are not of a sort to require scavenging of contents) the cleanliness of the privy itself should be systematically and strictly cared for. In cases where the use of the privy is common to all comers, servants of the Authority must of course keep it clean: and in cases where the use is common only to a defined group of houses or families, a definite understanding should be had as to the performance of the duty, either by the using families in regular rotation, or by their landlord or someone else on their joint behalf; and some appointed officer of the Authority must see strictly to the performance of the duty. Also in either case the privy must be protected against wilful damage, and wilful or negligent fouling: and vigilance should be used (particularly when the privies are first coming into local use) to detect, with a view to future prevention, any such abuses of the convenience.

Cleanliness as regards (so-called) dry refuse;

36.—In cases where the water-closet system is in full work, and where consequently no excrement-removal has to be done by cart, necessity still remains (at least in populous places) for a certain quantity of other scavenging. In order that nuisance shall not arise from the so-called dry refuse of houses, regularity and frequency of removal are first conditions; and in populous places such removal needs, of course, to be done as a systematic act of the Authority.

must advert to the putrescent quality of parts of it;

(*a.*) It has to be assumed that the dust-heap of each household contains almost invariably more or less of decomposing moist organic matter: the refuse or professed refuse (often far too lavishly so professed) of the different comestibles of the house: the peelings and other waste-bits of vegetables, the guts and other waste-bits of fish or birds, and so forth: and the necessity for frequent removal has to be estimated, not by what the mere fire-ash and other dry dust would require, but by the extreme offensiveness of these usual adjuncts. Households, not of the poorer classes, can, with proper management, keep their dust-heaps comparatively free from organic refuse: the larger households, namely, by daily utilisation of their kitchen-waste, and many smaller households by burning theirs on the kitchen fire. But the moderate amount of care which would serve in these ways to prevent nuisance is in a large proportion of the cases absent, and in other cases, immensely numerous, the suggested prevention would be quite impossible: for the domestic power of burning

refuse is limited by the poverty which must spare fuel, and many large towns have masses of poor population to whom such fires as would consume even the scant potato-peelings or spoilt cabbage-leaves of the house are luxuries entirely unknown. Scavenging-arrangements in relation to house-refuse in towns must therefore be framed with special reference to the fact that such refuse soon becomes highly offensive, and that, except where good domestic management exists, any two-days' retention of it makes a nuisance. It has to be remembered too as an actual fact, though representing a state of things which ought as far as possible to be resisted, that so-called dust-heaps in poor neighbourhoods very often contain some, and not rarely a good deal of excremental matter: cast there sometimes in mere dirty indolence, and sometimes because of a shameful want of other privy-accommodation.

must not let it accumulate or get wet;

(*b.*) House-refuse, awaiting removal, ought especially not to be exposed to wet. Liquids of course ought never to be thrown with it; and the ash-heap or fixed or moveable receptacle, used for ashes, ought always to be protected against rain. A moveable ash-tub, standing under a shed, is perhaps generally the best receptacle for dry-refuse, is particularly suited to the crowded parts of towns, and is the only proper arrangement for cases where the refuse must be carried through the house. If a fixed dust-bin be used, its walls should be smooth and impermeable, and its location and construction such as to give every facility for sweeping out. No receptacle should be of unnecessary size, but merely large enough to contain such accumulations as must occur in the proper intervals of removal.

may in some cases advantageously burn it.

(*c.*) It is not requisite in this place to say anything with regard to the eventual utilization of dry refuse. But it may be convenient here to note, with regard to cases where utilisation is not in view, that accumulations of offensive refuse may sometimes advantageously be burnt: namely, with the addition, if necessary, of lime, ashes, or other drying material, and with an admixture of cinders or small coal: and that this process (which gives an ash useful for deodorisation) may, in proper situations, be conducted either in coking-ovens, or in suitably-disposed open heaps.

Cleanliness as regards public ways;

37.—I perhaps hardly need note that the due scavenage of public ways is among the requisites for such local cleanliness as the public health requires. The filth of ill-kept streets contains, with the inorganic detritus of road and wheels, large quantities of the dung and urine of horses and occasionally other cattle: while in the courts and alleys of poor neighbourhoods, and even in many obscure streets, the case is made worse by an admixture, sometimes not small, of human excrement: and it is therefore essential that street-refuse should share the general obligation of filth to be promptly and properly removed. In quarters which will admit of it (and especially in poor neighbourhoods) the use of the hose in aid of the shovel and broom may be of great service.

and the sanitary importance of good pavement.

Public ways cannot be kept clean unless they are of suitable surface (so paved, namely, as not in any avoidable degree to favor the imbibition or other retention of filth) and are provided with proper rain-channels. In poor neighbourhoods this requires special attention: the extension of good pavement into all courts and alleys, whether legally public or private, is essential to their means of cleanliness: and generally with regard to all yards and curtilages, whether of rich or poor, the provision of impervious pavement on ground which adjoins houses is a valuable security in the same direction. The same rule applies to the basement of houses in regard of parts on which slop or other dirt is apt to fall.

Cleanliness as regards offensive sorts of business, and the keeping of animals.

38.—The general sanitary obligation to prevent injurious action from refuse-matters includes of course that sufficient regard shall be had to the conduct of those sorts of business which produce animal or vegetable refuse, or are in any other way apt to give putrescent effluvia or putrescent outflow. Thus, for instance, slaughtering-places, whether in towns or in villages, always require particular attention, as to their means of water-supply and drainage and ventilation, as to their having proper receptacles and regular prompt removal for all their refuse-products, as to their not occasioning any filthy soakage within or without their limits, and generally as to their being kept in a clean state and (as far as can be) without offensive odor. So of course, in populous places, all keeping of animals requires to be looked after with reference to the due removal of the refuse, and with reference also to animals not being kept (as great numbers of pigs often are) in situations so contiguous to houses that their keeping must necessarily be a nuisance: and, whether in towns or villages, no offensive outflow or soakage should be allowed from any cattle-shed or pig-sty which would not be allowed from a human privy. The action of Local Authorities, or of contractors under them, in collecting and disposing of the solid house-refuse and surface-filth of districts, requires, of course, the same sort of care as other sorts of business which deal with putrescent matter; as particularly as regards places of temporary deposit for collected refuse, and processes which the refuse may there have to undergo, the sites should be so chosen, and the processes so conducted, as not to cause avoidable nuisance.

Abatement of refuse-nuisances when found existing.

39.—In a different point of view to that of the preceding observations, I have yet to mention one more function which has to be discharged by those who would reduce the prevalence of Filth-diseases in England. In an earlier page I noted that, in proportion as a district should be well cared for in such respects as have now been explained, nuisances would so largely be prevented in it that comparatively few could present themselves for removal. Exceptionally however even under such circumstances, and abundantly of course in districts which have been ill-cared for, the abatement of various refuse-nuisances, and particularly the removal

of accumulated refuse, is a duty which has to be performed in order (so far as may still be possible) to the prevention of disease; and I have therefore here to advert to it in that sense.

With reference to houses which are said to have offensive smells, or which Inspectors find in a stinking state, it cannot be too distinctly understood that cleanliness and ventilation and dryness are the proper deodorisers of houses, and that artificial deodorisers will no more serve in their stead than, in regard of persons, perfumes could serve instead of soap and water. As against old frowsy and mouldy states, something supplementary may be got by free washings with hot lime-wash, or, in close spaces, by fumigation with sulphurous acid: but truly to deodorise a house is, to see that no house-refuse (not only no excremental matter, but also no other kind of dirt or refuse, nor any foul old wall-papers or other hangings) remain in or about it; and to see that all proper washings and limewashings be duly done; and to see that its basement be thoroughly dry; and to see that the air within it be not in any part stagnant, but always in course of renewal from without. Similarly, where the complaint is of drainage-odor within a house, search should be made whether the filth which house-drains are meant to carry away is retained in or near the premises in ill-made drains or in cesspools, or perhaps is leaking from house-drains within the house; or whether, inside the house, the inlets of drains and sinks are not properly trapped, or the pipes themselves have holes in them; or whether, outside the house, the ventilation of the drains and sewers is insufficient.

Where offensive matters have been allowed to accumulate in large quantities, the disturbance of them for removal (as in the emptying of ill-conditioned privies or cesspools) ought to be with special precautions; both in order to reduce the mere offensiveness of the process, and also to obviate, as far as may be, the dangers which the effluvia may represent. For the latter purpose, chemicals of an antiseptic sort are perhaps those which will be most generally applicable, and may be such, or in such combination, as also much to deodorise the filth; but, for the limitation of stink, privy-refuse should, at least in populous places, always be removed with special apparatus. Various refuse-heaps and mud-heaps, which for a time it may be impracticable or inexpedient to remove, should be covered, to the depth of two or three inches, with a layer of freshly-burnt vegetable charcoal in powder, or with a layer of clean dry earth, or with a layer of freshly-burnt lime; and earth near dwellings, if it has become foul by the soakage of decaying or vegetable matter, should be treated on the same plan.

Cleanliness as regards water-supply;

40.—Finally, it will be evident that, as the use of impure water is a chief way by which filth-infections get entry to the human body, so, for the prevention of filth-diseases, a very strict insistence on purity of water-supply is quite essential. And this in my opinion is a matter with regard to which no sort of compromise should be considered safe. When proper local arrangements shall

have been made for dealing with the excremental and other organic refuse-matter of inhabited places, many water-supplies which now are a daily danger to life will through that reform become comparatively safe: streams namely at once, and wells after sufficient lapse of time; but I venture to repeat that in this matter a very strict standard of cleanliness is in my opinion essential to safety.

from streams;

As regards running waters, the reports of the Rivers Pollution Commission seem to have clearly shewn that the fouling of natural watercourses by direct infusion of liquid refuse is a nuisance which, at least in all ordinary cases, Local Authorities may reasonably be required to suppress by application of the sewage to land; and though conditions are not yet defined under which streams, otherwise safe as drinking-water, can, without detriment to their potability, receive the outflow from sewage-receiving land, it may, I think, fairly be expected that to fulfil satisfactory conditions in that respect will in general be of no insuperable difficulty. Whether in particular cases populations may be so circumstanced that they cannot refrain from polluting streams, is a question which would in each separate case have to be judged on its own merits: only, if they must pollute the water, let the water be frankly recognised as unclean. Thus, regarding rivers as sources of drinking-water, one of two positions ought, I submit, to be consistently aimed at: either that, being a necessary source of domestic water-supply, the river shall be absolutely protected against pollution; or else that, being (in whatever degree) used as a sewer, it shall be classed as not fit to supply drinking-water.

from wells.

As regards wells, two cases must be distinguished. In the case of densely inhabited areas, it is certain that, however rightly the refuse-disposal may be conducted, the surface-wells can never be other than most dangerous sources of supply; and deep wells (which of course can only be trusted on condition that they are demonstrably protected against the chances of downward pollution) are only possible under certain geological conditions. It must therefore often be, that considerable centres of population will not be safely supplied with water unless the water come from outside the inhabited area; and in regard of the origin and course of any such extrinsic supply, the town population ought to be extremely vigilant. Among comparatively scattered populations, wells (and in great part surface-wells) must often be the source of supply: and it is of the greatest importance to discriminate between such as may and such as may not be safely used, and to ensure for all those which are to continue in use the completest attainable protection against dirt. Wells, adjacent to such privies and other filth-deposits as are now common in rural districts, are probably at present the chief means by which enteric fever spreads in such neighbourhoods; and however much the system of refuse-disposal in such districts may be improved, it can scarcely be hoped that surface-wells contiguous to dwellings (such as particularly the shallow dip-wells attached to cottages) will ever be safe against pollution. It is therefore greatly to be desired

that, in each village, there should as far as practicable be common centres of supply; if possible, springs or deep wells; and, in any case, with the most careful protection against foulings by slovenliness or by accident. In rural districts which (for geological or other reasons) cannot have safe water-supplies by springs or wells as above, arrangements for the collection and storage of rain-water, with every possible care that the water shall be collected and stored without pollution, are necessary to meet the wants of the population; and the receptacles which must be part of any such system ought, if practicable, to be above ground.

Reminder, that the preceding observations have aimed only at one group of removable causes of disease.

41.—Throughout the above observations I have always, I hope, sufficiently shewn that, while regarding Filth as the deadliest of our present removable causes of disease, I am far from regarding it as the only evil influence against which Sanitary Authorities have to contend; and though the object of my present Supplementary Report has been only to advert to the means by which enteric fever and the diseases ætiologically akin to it may be prevented, I would in conclusion observe, that, however admirable may be local arrangements of sewerage and scavenage and water-supply, and however complete in consequence may be the extinction of the diseases which arise exclusively from Filth, other excesses of disease will still have to be extinguished by such other preventive measures as are appropriate to their modes of production. On that subject I do not here pretend to enter: but having above (§ 5) specially named one influence as being, like Filth, of most destructive and probably universal operation throughout England, I would here specially, though but in a word, revert to it. And as regards that deplorable facility with which dangerous contagions of disease are allowed so generally to diffuse themselves in this country, often no doubt by co-operation of Filth, but also often independently of it, I would finally urge, as of interest to all districts, that, side by side with such endeavours for strict cleanliness as it has been the object of my preceding observations to recommend, the utmost vigilance should likewise everywhere be used with regard to all first cases of infectious disease, and everything be done, which the state of the law permits, to prevent the scattering of seeds of contagion.

JOHN SIMON.

APPENDIX.

No. 1.

USTRATIONS, from INSPECTORS' REPORTS of the four years 1870–3, of the circumstances in which ENTERIC FEVER is commonly found prevalent.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
ngdon - - - (Berks.)	1872	Regis.-General's Return.	Abingdon town council. Do. Improvement Commissioners.	*Dr. Thorne.* Enteric fever and diarrhœa. Water supply mostly from surface wells in porous soil soaked with excremental and other filth. Defective sewerage. Subsoil in part waterlogged. Many nuisances from waterclosets and privies. No proper removal of excrement. Poor housed in buildings unfit for habitation.
esley - - - (Notts.)	1870	Regis.-General's Return.	Annesley vestry - -	*Dr. Buchanan.* Enteric fever. Arrangements for excrement disposal and water supply such that people must drink their own excrement.
ledore & Northam (Devon.)	1870	Regis.-General's Return.	Northam local board -	*Dr. Thorne.* Epidemics of enteric fever and scarlatina; chiefly in Appledore, where streets and courts extremely ill-constructed and ill-drained, with excrement and refuse lying about everywhere. Water sources befouled. At Northam polluted water and excrement nuisances.
nley - - - (Yorks.)	1872	Local information.	Leeds corporation -	*Dr. Ballard.* Enteric fever first attacked dairyman, and then spread to a large number of his customers. His well was found to be extensively contaminated with sewage. (See special report appended, No. 4.)
ton in Makerfield (Lancaster.)	1872	Regis.-General's Return.	Ashton local board -	*Mr. Radcliffe.* Epidemic of enteric fever. Water supply insufficient, and partly from questionable sources. Want of outlets for house drains. Accumulations of excrement. Want of scavenging.
lby-cum-Hexthorpe (Yorkshire.)	1873	Regis.-General's Return.	Doncaster rural sanitary authority.	*Dr. Thorne.* Frequent prevalence of enteric fever. Defective sewerage and drainage. Polluted water supply. Improper means for the disposal of excrement and refuse.
nbury - - - (Oxon.)	1870	Regis.-General's Return. Several fever deaths in a town where fever had previously been much reduced by sanitary action.	Banbury local board -	*Dr. Buchanan.* Some of the fever found to have been imported; room for further sanitary improvement. In regard of nuisance removal, many conditions worse than on 1866 inspection.
rking - - - (Essex.)	1873	Regis.-General's Return.	Romford rural sanitary authority.	*Dr. Harries.* Enteric fever prevalent. Unwholesome water. System of drainage and sewerage imperfect. Passage of sewer air into houses. No arrangement for removal of excrement and refuse. Soil saturated with filth. Overcrowding and other nuisances.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Barking - - - (Lodge Farm.)	1873	Question of relation of cases of enteric fever to the sewage irrigation.	—	*Dr. Buchanan.* Enteric fever had occurred among persons living in Barking and working on the sewage farm. No sufficient evidence whether the cause of the fever was on the farm, or in the town. Water of a well on the farm derived largely from sewage effluence. Particular excremental nuisances also in the neighbourhood of this well.
Barlborough - - (Derbyshire.)	1869	Petition from inhabitants.	Barlborough vestry -	*Dr. Thorne.* Prevalence of enteric fever. Nuisances from drains, privies, and waterclosets, and impure water supply in certain parts of the parish.
Barnet - - - (Herts.)	1871	Local complaint.	East Barnet vestry. Barnet guardians.	*Mr. Radcliffe.* Prevalence of fever. Nuisances from cesspools and foul ditches. Water good, but service reservoir open and dirty. Proper system of sewerage required.
Barrow-in-Furness - (Lanc.)	1872.	Regis.-General's Return.	Barrow corporation -	*Mr. Radcliffe.* Prevalence of enteric fever. A rapidly extending town with the population growing faster than house accommodation. Consequent overcrowding. Sewerage imperfect. A considerable portion of town has privies with middensteads, giving rise to much nuisance.
Basingstoke - - (Hants.)	1871	Local complaint.	Town council - -	*Dr. Ballard.* Enteric fever. Polluted wells. Air and soil befouled with excrement from cesspits. No proper drainage. General neglect of sanitary measures.
Bedford - - -	1870	Regis.-General's Return.	Bedford guardians, local board, Wootton vestry - -	*Dr. Thorne.* Endemic enteric fever. Foul and scanty water, with excrement nuisances.
Bideford - - - (Devon.)	1870	Regis.-General's Return.	Bideford local board	*Dr. Thorne.* Prevalence of fever and scarlet fever. Pollution of earth, air, and water by excremental soakage. Badly constructed and unventilated cottages. Abundant other nuisances.
Biggleswade - - (Beds.)	1871	Regis.-General's Return.	Biggleswade vestry and guardians, Potton vestry.	*Dr. Corfield.* Prevalence of scarlatina, measles, and enteric fever. General pollution of earth, air, and water by excrement. Want of privy accommodation. Spread of disease from overcrowded plaiting schools.
Bingham - (Notts.)	1872	Regis.-General's Return.	Bingham guardians. Bingham vestry.	*Dr. Thorne.* Imperfect drainage. Surface soil saturated with excremental filth. Water polluted.
Bishops Stortford (Herts.)	1873	Regis.-General's Return.	Local board - -	*Dr. Thorne.* Frequent prevalence of enteric fever. Polluted water supply. Sewers imperfectly ventilated, and consequent nuisance from the escape of sewer air into dwellings. Imperfect means for disposal of excrement and refuse. Privies and waterclosets badly constructed, the latter not properly supplied with water.
Blyth - - - (Northumberland.)	1872	Regis.-General's Return.	Blyth local board. Cowpen local board. Tynemouth guardians.	*Dr. Airy.* Enteric fever endemic in Cowpen township, where the water supply is insufficient and bad. Sewers not properly ventilated. System of excrement removal defective.

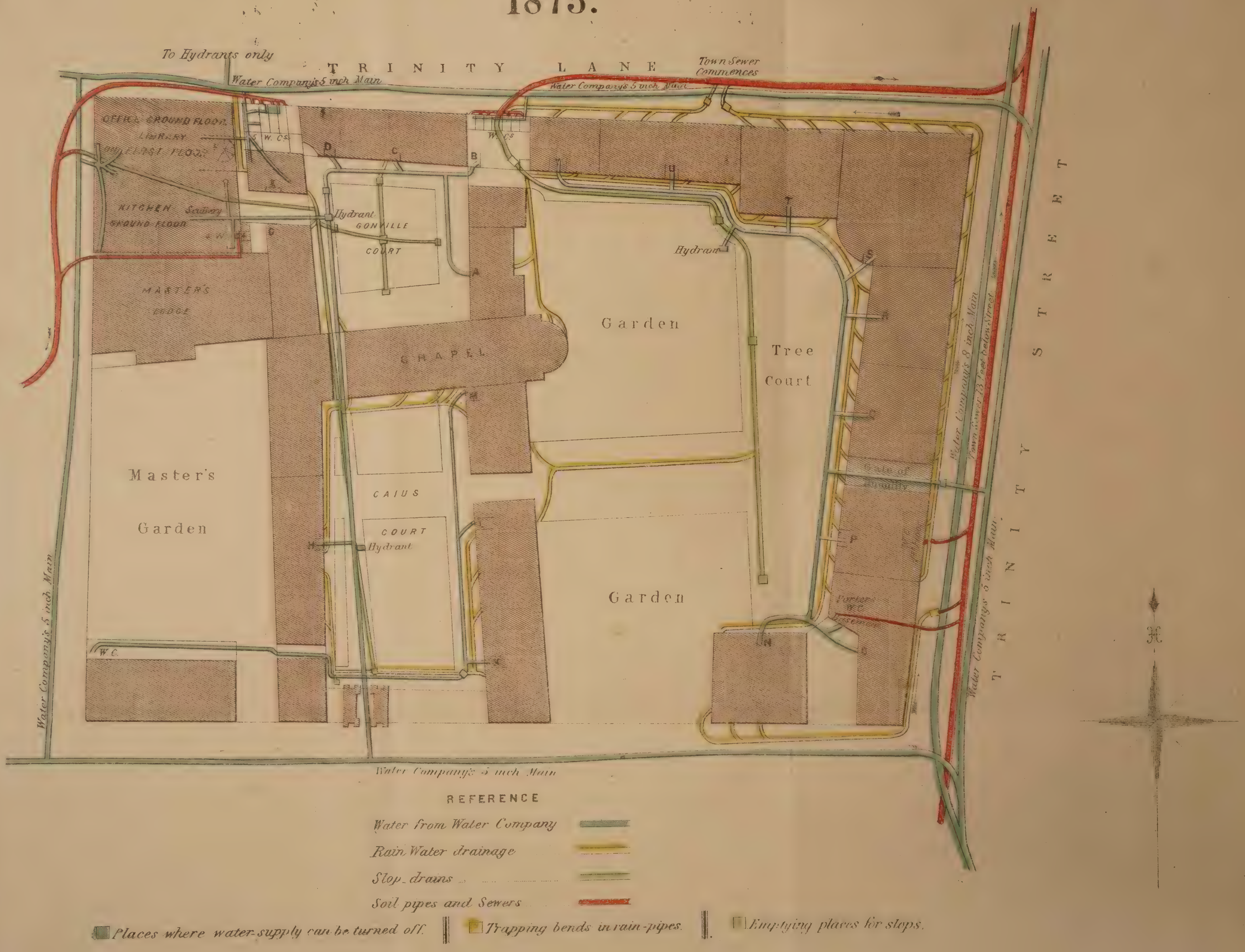
Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
on Registration istrict.	1871	Regis.-General's Return.	Bolton Local board. Bolton guardians and various vestries. Farnworth local board. Kearsley do. Halliwell do. Astley Bridge do.	*Dr. Ballard.* High mortality especially of children, and great prevalence of diarrhœa. *Bolton town.* Houses of operatives crowded together, badly ventilated, and often unfit for human habitation. Badly constructed privies and ashpits, and neglect of them by the local authority. Imperfect scavenging and cleansing of the town, insufficient arrangements for sanitary inspection, and almost complete neglect of the provisions of the Sanitary Act, of 1866, relating to the arrest of the spread infectious diseases. *Farnworth, Kearsley, Halliwell, and Astley Bridge (in varying degrees).* Houses badly ventilated and premises undrained; overcrowding; privies and ashpits badly constructed and neglected; nuisances not removed; insufficient arrangements for sanitary inspection, and neglect of the provisions of the Sanitary Act, 1866, relating to the arrest of the spread of infectious diseases. *Other parts of the Bolton Union,* Houses badly ventilated or unfit for human habitation; premises undrained; overcrowding; insufficient privy accommodation; privies and ashpits badly constructed and neglected; nuisances not removed; in some places insufficient and bad supply of water; insufficient arrangements for sanitary inspection, and general neglect of the provisions of the Sanitary Act, 1866, relating to the arrest of the spread of infectious diseases.
ackley - - - orthamptonshire.)	1871	Regis.-General's Return.	Brackley guardians, and joint Sewerage Committee. Newbottle vestry.	*Dr. Buchanan.* Epidemic of enteric fever. Accumulation of excrement. Wells near cesspools.
adford - - - (Yorks.)	1871	Regis.-General's Return.	Local board - -	*Mr. Radcliffe.* Prevalence of fever and diarrhœa. Much nuisance from privies with middensteads, imperfect drainage of courts, and open watercourses. Defective sanitary administration.
- - -	1872	Regis.-General's Return.	Bradford corporation	*Mr. Radcliffe.* Sanitary defects pointed out in last year's report not removed. Much nuisance.
ecknock - - -	1873	Regis.-General's Return.	Town council - -	*Dr. Harries.* Enteric fever. Defective drainage. Imperfect system of excrement disposal. Cesspits leaky and rarely emptied, and consequent pollution of soil water. Badly constructed and improperly placed privies. Some houses unfit for habitation. Nuisances from animals and from accumulations of manure.
idport - - - (Dorset.)	1870	Continued prevalence of fever, and unsatisfactory answer from board respecting action taken on former advice of Department.	Bridport local board -	*Dr. Buchanan.* Increased prevalence of epidemic disease; continuance of unwholesome conditions previously reported; general foulness of water; accumulations of excrement; general neglect of sanitary functions by board.
uton - - - (Somerset.)	1872	Regis.-General's Return.	Wincanton guardians. Bruton vestry.	*Dr. Home.* Enteric fever. Excremental and other nuisances close to dwellings. Soil and water polluted with sewage.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector and the chief facts reported by him.
Bulwell - - - (Notts.)	1871	Report of district medical officer.	Bulwell vestry. Basford guardians.	*Dr. Harries.* Epidemic of enteric fever. Pollution of water by excrement nuisances. Privies filthy and insufficient.
Burbage - - - (Leicestershire.)	1871	Report from local registrar.	Aston Flamville vestry. Hinckley guardians.	*Dr. Harries.* Epidemic of enteric fever connected with use of water from a well communicating with a privy probably infected by an imported case of enteric fever. Bad excrement management, and improper water supply generally.
Burton Latimer - - (Northampton.)	1872	Local information.	Kettering rural sanitary authority.	*Dr. Thorne.* Epidemic of enteric fever. Water suppply obtained from wells polluted by soakage from privies and cesspools. Sewerage and drainage defective. Accumulations of excrement and refuse. Nuisance from piggeries. Overcrowding.
Calstock - - (Cornwall.)	1871	Local information.	Calstock vestry. Tavistock guardians.	*Dr. Blaxall.* Frequency of epidemics; constant prevalence of enteric fever and diarrhœa. Continuance of unwholesome conditions previously reported. General absence of proper drainage. Want of privy accommodation. Excrement nuisances. Polluted water.
Campden - - - (Gloucestershire.)	1873	Local information.	Shipston-on-Stour rural sanitary authority.	*Dr. Harries.* Enteric fever has been more or less prevalent for the last three years. Polluted wells. Nuisances from house drainage and from defective system of excrement and refuse disposal.
Cardigan - - -	1870	Regis.-General's Return.	Town council - -	*Mr. Radcliffe.* Insufficient privy accommodation; imperfect sewerage; nuisances from collections of manure, from ashpits, and from pigsties; foul brook through the town.
Carlton - - - (Notts.)	1871	Local complaint.	Carlton vestry. Basford guardians.	*Dr. Harries.* Enteric fever epidemic. No proper water supply. Privies few and bad. Nuisances abounding.
Castle Cary - - (Somerset.)	1872	Regis.-General's Return.	Wincanton guardians. Castle Cary vestry.	*Dr. Home.* Frequent prevalence of enteric fever. Old-standing faults of drainage and water supply, but works of sanitary improvement in progress.
Castleford - - - (Yorks.)	1870	Regis.-General's Return.	Local board - -	*Mr. Radcliffe.* Prevalence of fever. Excremental nuisances. Sewerage defective. New water supply in course of provision.
Chatham (*See* Rochester.)				
Chippenham - (Wilts.)	1870	Regis--General's Return.	Chippenham local board.	*Dr. Buchanan.* Prevalence of enteric fever and other epidemics. Insufficient and impure water supply; want of privy accommodation and of a proper system of excrement disposal; faulty house construction.
Chipping Sodbury Union (Gloucester).	1872	Report of Vaccination Inspector.	Chipping Sodbury rural sanitary authority.	*Dr. Ballard.* Prevalence of enteric fever and diarrhœal affections. Absence of sanitary supervision. Want of drainage and pure water supply in various parts of union, especially in Marshfield. Unhealthy state of cottages.
Chittlehampton - - (Devon)	1872	Regis.-General's Return.	Chittlehampton vestry South Molton guardians.	*Dr. Home.* Prevalence of enteric fever. Drainage imperfect. Privies ill-constructed, some cottages without privies. Accumulations of excrement. Polluted water. Nuisances.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
ifton Reynes - - (Bucks)	1872	Local information.	Newport Pagnell guardians. Clifton Reynes Vestry.	*Dr. Thorne.* Enteric fever. Water supply partly polluted. Some nuisances.
mbrooke - - - (Warwick.)	1873	Report from Vaccination Inspector.	Stratford-on-Avon rural sanitary authority.	*Dr. Ballard.* Enteric fever had been imported from Leamington, and spread in the house to which the patient was brought, and to the two adjoining houses. Water used in these houses was obtained from a well exposed to pollution. Imperfectly constructed privies in the village generally.
oventry (neighbourhood of). Red Lane Estate.)	1870	Communication from local registrar.	Coventry guardians. Foleshill guardians. Coventry local board. Foleshill vestry.	*Dr. Thorne.* Enteric fever found seriously prevalent, and ascribed to use of polluted water, want of efficient sewerage, and various filth accumulations.
royde - - - (Devon)	1870	Regis.-General's Return.	Barnstaple guardians. Georgeham vestry.	*Dr. Home.* Serious prevalence of enteric fever. No public sewerage or house drainage. Accumulations of excrement and refuse. Nuisance from pigsties and dungheaps. Water sometimes used from polluted source.
wmbran and Pontnewydd (Mon.) -	1870	Regis.-General's Return.	Pontypool guardians. Llanvrechfa and Llantarnam vestries.	*Mr. Radcliffe.* Prevalence of enteric fever. Defective and sometimes impure water supply, and insufficient means of excrement removal.
oncaster - - - (Yorks.)	1873	Regis.-General's Return.	Town council.	*Dr. Thorne.* Large general and infantile mortality; endemic enteric fever and diarrhœa; epidemic scarlet fever and smallpox. Polluted water. Bad means of excrement disposal. Escape of sewer air into dwellings. Nuisances from piggeries. Neglected courts.
raycott - - - (Derby.)	1872	Regis.-General's Return.	Shardlow guardians.	*Dr. Beard.* Enteric fever. Defective drainage. Accumulation of excrement. Want of proper sanitary supervision.
udley - - - (Worc.)	1871	Regis.-General's Return.	Town council and local board.	*Dr. Thorne.* Endemic scarlatina, typhus, enteric fever, and diarrhœa. Defective and insufficient sewerage. Polluted water in private wells. Inefficient excrement and refuse disposal. Ill-constructed, filthy, and overcrowded houses. Nuisances from pigsties.
astbourne - - - (Sussex.)	1870	Local complaint.	Eastbourne local board	*Dr. Thorne.* Prevalence of enteric fever. In the new town sewers not properly ventilated, waterclosets not supplied with water. In the old town drinking water polluted.
astwood. (*See* Greasley.)				
cton - - - - (Northampton.)	1872	Report of district medical officer.	Wellingborough rural sanitary authority.	*Dr. Buchanan.* Fever caused by the use, for drinking, of water from a brook polluted by sewage. Subsequent spread through excremental nuisances. Wells polluted by soakage from privies and pigstyes. Overcrowded cottages.
mberton - - - (Bucks.)	1872	Local information.	Newport Pagnell guardians. Emberton Vestry.	*Dr. Thorne.* Enteric fever. Dilapidated cottages. Water polluted by sewage. Want of system for disposal of excrement.
orest Hill - - - (Kent.)	1870	Local complaint	Lewisham board of works. Camberwell vestry.	*Mr. Radcliffe.* Prevalence of zymotic diseases. Disease produced by deficient and imperfect sewerage, and by foul cesspools.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Frogmore and Two Waters - - - (Herts.)	1870	Local complaint.	Hemel Hempstead guardians. Hemel Hempstead vestry.	*Dr. Thorne.* Enteric fever found to be endemic. Drains choked and ground saturated with filth; privies and ashpits foul, and polluted drinking water.
Glastonbury - - (Somerset.)	1870	Local complaint.	Wells guardians. Glastonbury town council.	*Mr. Radcliffe.* Excessive mortality from scarlatina and enteric fever. Water supply insufficient; sewers defective; arrangements for excrement disposal utterly bad.
Goole - - - - (Yorks.)	1871	Report of Vaccination Inspector.	Goole vestry and guardians. Hook vestry.	*Dr. Home.* Epidemic diarrhœa, some choleraic. Occasional prevalence of enteric fever. "Every kind of in- "sanitary condition in the most "aggravated form." Bad water; excrement accumulation; imperfect sewerage; houses huddled together without plan. Interiors overcrowded and fœtid.
Greasley and Eastwood (Notts.)	1870	Regis.-General's Return.	Basford guardians. Eastwood vestry. Greasley vestry.	*Dr. Buchanan.* In both parishes enteric fever had prevailed, along with general pollution of air and water by excrement; insufficient water supply, and various nuisances. The vestries had practically decided not to perform their duties under the Sanitary Acts.
Great Grimsby - - (Linc.)	1871	Regis.-General's Return.	Local board - -	*Dr. Home.* Prevalence of diarrhœa and fever; polluted water; inefficient system of excrement and refuse removal; incomplete drainage and sewerage. Nuisances. Houses unfit for habitation. Inadequate sanitary supervision.
Guisborough - (Yorks.)	1873	Regis.-General's Return.	Guisborough local board.	*Dr. Harries.* Serious prevalence of enteric fever. Polluted water. Nuisance from privies and refuse. Imperfect arrangements for scavenging. Ill-built and overcrowded houses.
Hawkesbury Upton - (Glouc.)	1872	Report of Vaccination Inspector.	Chipping Sodbury rural sanitary authority.	*Dr. Ballard.* Enteric fever. No public drainage. Open cesspools. Sewage habitually soaking into wells.
Heanor - - - (Derby.)	1870	Regis.-General's Return.	Heanor local board. -	*Dr. Buchanan.* Enteric fever. Offensive privies; water supply very precarious, and in some cases of doubtful purity.
Helions Bumpstead - (Essex and Cambs.)	1871	Local complaint.	Risbridge guardians Helions Bumpstead vestry	*Dr. Airy.* Epidemic enteric fever. Great accumulations of excrement and filth. Foul ditches. Much of the water supply impure.
Helston - - - (Cornwall.)	1870	Local complaint	Helston corporation.	*Dr. Buchanan.* Enteric fever had been prevalent. Water supply scarce and of doubtful quality; little or no drainage; want of privy accommodation; bad arrangements for excrement removal; the town generally filthy.
Hennock - - - (Devon.)	1870	Local complaint.	Hennock vestry - -	*Dr. Hunter.* Enteric fever in Hennock hamlet and in Chudleigh Knighton hamlet; 47 cases of diphtheria, 10 fatal, in six months. Want of privy accommodation and ashpits. Water supply of doubtful purity, and not duly accessible.
Hersham - - - (Surrey.)	1872	Local information - -	Walton - on - Thames vestry.	*Dr. Thorne.* Prevalence of fever, scarlet and enteric. No drainage. Water used from wells polluted by soakage from privies and cesspools. Excremental and other nuisances.

GROUND PLAN
OF
GONVILLE & CAIUS COLLEGE
1873.



REFERENCE

Water from Water Company

Rain Water drainage

Slop-drains

Soil pipes and Sewers

Places where water-supply can be turned off. | Trapping bends in rain-pipes. | Emptying places for slops.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Higham Ferrers - (Northampton.)	1871	Local complaint.	Higham Ferrers vestry, Wellingborough guardians.	*Dr. Home.* Habitual prevalence of enteric fever, not only in sewered houses. Ground sodden with leakage from privy pits and cesspools. Water polluted. Insufficient ventilation of sewers. Accumulations of excrement and house filth. Trade nuisances.
Hucknall-under-Huthwaite. (Notts.)	1873	Regis.-General's Return.	Local board - -	*Dr. Harries.* Prevalence of enteric fever. Water supply insufficient and liable to pollution from surface drainage. Imperfect system of sewerage and of excrement disposal. Roads badly constructed and in a foul condition. Nuisances.
Hucknall Torkard (Notts.)	1872	Report from local Registrar.	Local board - -	*Dr. Harries.* Enteric fever endemic. Water supply plentiful, but obtained chiefly from wells which are in a porous soil, and liable to pollution from privies and surface drainage. Insufficient privy accommodation. No systematic provision for excrement disposal. Foul accumulations of all kinds. Serious overcrowding of houses in which colliers lodge.
Hugglescote, Donnington, Coalville, and Packington. (Leic.)	1871	Regis.-General's Return.	Vestry of Hugglescote and Donnington, Ashby-de-la-Zouch guardians.	*Dr. Home.* Enteric fever severely epidemic. Air and water polluted by excrement. No proper drainage. Nuisances from privies and pigsties.
Huddersfield - - (Yorks.)	1872	Regis.-General's Return.	Huddersfield corporation - - -	*Dr. Buchanan.* Epidemic of enteric fever. Sewers defective. Arrangements for excrement disposal inadequate. Certain water supplies largely polluted with sewage. Necessity for appointment of medical officer of health, and for construction of a hospital for infectious diseases, and a mortuary. Corporation have improvements in progress.
Ilkeston - - - (Derby.)	1870	Local complaint.	Ilkeston local board -	*Dr. Buchanan.* Enteric fever found to be endemic. Imperfect drainage; air and drinking water polluted by excrement; filthy ashpits.
Ilminster - - - (Som.)	1871	Report from Guardians.	Ilminster sewage board. Chard guardians.	*Dr. Blaxall.* Considerable epidemic of enteric fever. Foul open sewers. Excremental filth everywhere, saturating ground and contaminating most of drinking water.
Ingham - - - (Lincoln.)	1870	Local information.	Ingham vestry -	*Mr. Radcliffe.* Fever, chiefly enteric, had been prevalent, and had been caused by polluted water; excremental pollution of earth about houses from defective house drains and bad privies. Overcrowding.
Kilgerran - - - (Pembroke.)	1870	Regis.-General's Return.	Kilgerran vestry -	*Mr. Radcliffe.* Very scanty water supply: liable to become polluted. No proper provision for excrement or refuse disposal. Imperfect sewerage.
Kingsthorpe - - (Northampton.)	1870	Regis.-General's Return.	Kingsthorpe vestry -	*Dr. Buchanan.* Prevalence of scarlatina, enteric fever, and diarrhœa. Want of drainage. Water polluted. Accumulations of excrement and filth. No means of isolation or disinfection.
Leeds - - - (Yorks.)	1871	Regis.-General's Return.	Corporation - -	*Mr. Radcliffe.* Excessive mortality from diarrhœa and fever. Most offensive form of excrement disposal by common privies. Faulty regulation of sewers. Inadequate water supply. Ill-constructed buildings. Want of scavenging.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Leigh - - - (Lanc.)	1872	Regis.-General's Return.	Local board, Atherton. Ditto West Leigh. Ditto Pennington. Ditto Bedford.	*Mr. Power.* Epidemic of enteric fever. Privy accommodation insufficient. Polluted water used from wells close to drains, privies, and middens. Accumulations of excrement. Imperfect sewers. Badly constructed and arranged houses.
Littleport - - - (Cambs.)	1873	Regis.-General's Return.	Ely rural sanitary authority.	*Dr. Thorne.* Enteric fever endemic. Water supply generally insufficient and in part polluted. Nuisances from imperfect drainage, from cesspools and privies. No proper provision for removal of excrement and refuse. Some cottages dilapidated and otherwise unfit for habitation.
Llanelly - - - (Brecon.)	1872	Regis.-General's Return.	Brynmawr local board. Crickhowell guardians.	*Dr. Harries.* Prevalence of enteric fever. Water polluted by sewage. Nuisances. Many houses without privies. No system of excrement removal or of scavenging.
Llanelly - - - (Carmarthen.)	1870	Regis.-General's Return.	Llanelly local board -	*Mr. Radcliffe.* Prevalence of enteric fever. Provisions for excrement disposal and refuse removal fundamentally defective. Drainage defective, and water supply inadequate for the wants of the sewer system.
Lye, The - - - (Worc.)	1873	Regis.-General's Return.	Stourbridge rural sanitary authority.	*Dr. Ballard.* Enteric fever. No proper drainage. Insufficient supply of water. Polluted wells. Nuisances from accumulations of manure and from privies and ashpits.
Macclesfield - - (Certain portions of the Union.)	1873	Information from General Inspector and from rural sanitary authority.	Macclesfield rural sanitary authority. Bollington local board.	*Dr. Thorne.* Epidemic of scarlet fever, and frequent prevalence of enteric fever and diarrhœa. No means either of isolation or of disinfection. Bad cottage property. Polluted water. Insufficient and imperfect drainage. Bad arrangements for disposal of excrement and refuse.
Malpas - - - (Chesh.)	1871	Regis.-General's Return. Complaint of rector.	Malpas vestry - -	*Dr. Stevens.* Enteric fever. Drainage defective. Water insufficient and impure. Abundant filth accumulations. Privy accommodation bad. No proper means of refuse disposal. Dwellings unfit for habitation and overcrowded.
Margate - - - (Kent.)	1873	Local complaint.	Town Council - -	*Dr. Harries.* Constant prevalence of fever, diarrhœa, and other low types of disease. Main sewer so constructed as to form a reservoir for sewage, which the tide occasionally drives back through the gratings. Nuisances from sewage outfalls. Rocks and beach near jetty covered with sewage slime. Cesspits estimated to cover aggregate extent of three acres; many under houses, and discharging foul air into them, the sewage sometimes even welling up through the floors. Various nuisances.
Marylebone - (Middl.)	1873	Local information.	Marylebone vestry -	*Mr. Radcliffe.* See special report appended, No. 6.
Mendham - - - (Suffolk.)	1873	Representations of Hoxne rural sanitary authority.	Hoxne rural sanitary authority.	*Dr. Airy.* Continued prevalence of enteric fever. Wells polluted by sewage. Insufficient privy accommodation. No systematic removal of excrement.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Mexborough - - (Yorks.)	1873	Regis.-General's Return.	Mexborough local board.	*Dr. Thorne.* Habitual prevalence of enteric fever. Epidemic of scarlet fever and small pox. Bad and insufficient drainage. Polluted water. Accumulations of excrement and filth. No proper means of disinfection and isolation.
Middlesborough - (Yorks.)	1871	Regis.-General's Return. Memorial as to nuisance.	Middlesborough local board. Stockton guardians.	*Dr. Buchanan.* Prevalence of smallpox, scarlatina, diarrhœa, and fevers. Pervious sewers, ill-ventilated. Imperfect arrangements for excrement disposal. Old houses ill-constructed.
Milborne Port - - (Somerset.)	1872	Regis.-General's Return.	Wincanton guardians. Milborne Port vestry.	*Dr. Home.* Constant prevalence of fever. Nuisances close to dwellings. Water and air polluted with sewage.
Milton and Sittingbourne. (Kent.)	1870	Regis.-General's Return.	Milton guardians. Milton Commissioners. Sittingbourne local board.	*Dr. Buchanan.* Much enteric fever. In Milton town great defects in drainage, in excrement disposal, and in water supply, with need for "almost all sanitary improvements "which it is possible to enumerate." In Sittingbourne inefficient arrangements for excrement removal, and wells polluted.
Moseley and Balsall Heath. (Worc.)	1873	Memorial from inhabitants.	Balsall Heath local board. King's Norton rural sanitary authority.	*Dr. Ballard.* Enteric fever broke out at a dairyman's. Fever evacuations thrown out into the privy. Fever spread among customers of two dairymen whose wells were polluted by soakage from this privy. (See special Report appended, No. 5.)
Northam. (*See* Appledore.)				
Northampton - -	1871	Regis.-General's Return.	Town council and improvement commissioners.	*Dr. Buchanan.* Prevalence of scarlatina, fevers, and diarrhœa. Saturation of soil in low-lying parts. Cesspool soakage. Foul private wells. Improved means of nuisance removal and excrement disposal required.
Nunney - - (Somerset.)	1872	Report from local registrar.	Frome rural sanitary authority.	*Dr. Ballard.* Prevalence of enteric fever. Water supply obtained chiefly from a brook largely polluted by sewage. Insufficient privy accommodation. No proper system of excrement disposal.
Oldbury - - - (Worc.)	1870	Regis.-General's Return.	Oldbury local board -	*Dr. Thorne.* Prevalence of fever and diarrhœa. The place almost absolutely destitute of drainage; water supply very defective, and largely polluted. Nuisance from pigsties, foul privies, middens, and refuse heaps.
Olney - - - (Bucks.)	1872	Local information.	Newport Pagnell guardians. Olney vestry.	*Dr. Thorne.* Constant prevalence of enteric fever. Imperfect drainage. Soil round wells sodden with soakage from privies. Cottages without privies or ashpits. Want of system for disposal of excrement.
Ovenden - - - (Yorks.)	1873	Regis.-General's Return	Local board - -	*Dr. Thorne.* Large general and infantile mortality. Prevalence of enteric and scarlet fever. Instances of water pollution. Insufficient means of drainage. Bad means of excrement disposal.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	The Inspector and the chief facts reported by him.
Oxford - - -	1870	Regis.-General's Return.	Oxford local board -	*Dr. Buchanan.* Large mortality from epidemics, especially scarlatina, enteric fever, and diarrhœa. Saturation of soil in low-lying parts. Sewer system incomplete. Pollution of streams by sewage. Questions about public water supply. Other water sources all dangerous. Bad construction of poor houses. Insufficient sanitary supervision. Inadequate measures for preventing contagion.
Packington - - (Leic. and Derby.)	1871	Information from local Registrar.	Vestries of Packington, Ibstock, and Whitwick; local board, Whitwick. Ashby-de-la-Zouch guardians.	*Dr. Home.* Severe epidemic of enteric fever. Water supply polluted. Very serious accumulations of excrement and other filth, and other nuisances.
Penally - - - (Pembroke.)	1870	Regis.-General's Return.	Pembroke guardians. Penally vestry.	*Mr. Radcliffe.* Much enteric fever. Water sources liable to pollution. Privy accommodation bad or absent. No proper means of refuse disposal.
Penryn - - - (Cornwall.)	1870	Local complaint.	Falmouth guardians. Penryn Town Council. St. Gluvia's vestry. Budock vestry.	*Dr. Thorne.* Considerable outbreak of enteric fever. Streets lined with excrement and refuse. Want of sewers, privies, and ashpits. Water sources polluted. Overcrowding.
Porchester - - (Hants.)	1872	Report from inhabitants.	Fareham rural sanitary authority.	*Dr. Stevens.* Prevalence of small-pox and fever. No system of drainage. Privy accommodation bad and insufficient. Water supply obtained from shallow wells into which sewage soaks. Nuisances from pig sties, &c. Some of the cottages unfit for habitation
Pontnewydd. (*See* Cwmbran.)				
Radford - - - (Notts.)	1870	Regis-General's Return.	Radford vestry. Radford guardians.	*Dr. Thorne.* Prevalence of fever and diarrhœa. Want of privies. Sewers insufficient and ill-ventilated. Water, air, and soil generally contaminated by excrement.
Do. - - -	1872	- - - - -	Do. - - -	*Dr. Thorne.* Further prevalence of enteric fever. Escape of sewer air into houses from unventilated sewers. Water source polluted by soakage from privies. Sanitary measures urged in previous report only in small part carried out. Prevalence of small-pox as well as of enteric fever.
Rainford - - - (Lanc.)	1871	Local information.	Rainford vestry. Prescot guardians.	*Dr. Beard.* Prevalence of enteric fever. Pollution of water from sewage and soakage from dung heaps.
Rochester and Chatham (Kent.)	1870	Regis.-General's Return.	Medway guardians, Rochester Town Council, St. Margaret's Paving Commissioners, Rochester Paving Commissioners, Chatham local board, Gillingham vestry, and various other bodies.	*Dr. Buchanan.* Prevalence of fever. Division of sanitary functions among numerous authorities. Absence of soil drainage in various low-lying parts. Bad arrangements for excrement disposal. Pollution of many private wells. Some overcrowding. Insufficient provision for removal of nuisances. These conditions more in Rochester than in Chatham.
Rolvenden - - (Kent.)	1870	Local information.	Tenterden guardians. Rolvenden vestry.	*Dr. Thorne,* Enteric fever found epidemic. Water supply polluted. Want of drainage and proper means of excrement disposal. Abundant nuisances.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
oss - - - - (Hereford.)	1870	Regis.-General's Return.	Ross improvement commissioners.	*Dr. Thorne.* Epidemic scarlatina and frequent enteric fever. Want of means for excrement and refuse removal. Water supply polluted. Cattle nuisances.
otherham - - - (Yorks.)	1872	Local information.	Corporation - -	*Dr. Ballard.* Enteric fever endemic. Neglected state of courts inhabited by the poor. Sewers defective. Nuisances from overfull privies. Air, soil, and water polluted with sewage.
uthin - - - (Denbigh.)	1871	Local complaint.	Local board - -	*Dr. Home.* Apparently typhus as well as enteric fever had prevailed. The latter had chiefly attacked severed houses. Ground saturated with excrement and water supplies impure. Unventilated, dirty, crowded houses.
t. Dogmaels - - (Pemb.)	1870	Regis.-General's Return.	St. Dogmael's vestry.	*Mr. Radcliffe.* Prevalence of fever. Insufficient water supply, liable to pollution. Imperfect drainage. Bad privies, and want of privy and refuse arrangements.
t. Just - - - (Cornwall.)	1870	Regis.-General's Return.	Penzance guardians. St. Just vestry.	*Dr. Buchanan.* Scarlatina very fatal. Enteric fever habitually present. No precautions against infection. Almost universal foulness of soil and air about houses. Want of provision for excrement removal. Scanty and impure water supply. Unwholesome houses.
altash - - - (Cornwall.)	1871	Local information.	Vestry - - - -	*Dr. Hunter.* Prevalence of fever. Danger of epidemics from bad privies. Water supply inadequate.
cothern - - - (Lincoln.)	1870	Report from Inspector.	Lincoln guardians. Scothern vestry.	*Mr. Radcliffe.* Enteric fever prevalent for last two years. Ground sodden with filth from imperfect drains. Bad privies and refuse receptacles. Water probably polluted.
heerness - - - (Kent.)	1870	Regis.-General's Return.	Sheppey guardians. Sheerness local board.	*Dr. Buchanan.* Prevalence of enteric fever. Universal accumulations of excrement. Imperfect water supply. Deficient supervision over sub-let and lodging houses. Inefficient dealing with nuisances.
herborne - - - (Dorset.)	1873	Information from Vaccination Inspector.	Local board - -	*Dr. Blaxall.* Sudden and severe outbreak of enteric fever, affecting chiefly houses supplied from public waterworks. Water in surface mains exposed to contamination from waterclosets. Many ordinary sanitary defects. (See Special Report appended No. 2.)
ittingbourne (*see* Milton).				
kegby and Fulwood - (Notts.)	1873	Regis.-General's Return.	Mansfield rural sanitary authority.	*Dr. Harries.* Enteric fever. New houses at Skegby built without due regard to sanitary considerations. Polluted water. Nuisance from drainage.
pinkhill - - - (Eckington.) (Worc.)	1870	Local information.	Eckington vestry -	*Dr. Thorne.* Habitual prevalence and present outbreak of enteric fever. Water of public and other wells polluted. Drains defective. Want of privies and ashpits; accumulations of filth.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Stamford - - - (Linc.)	1870	Local complaint.	Stamford town council.	*Mr. Radcliffe.* Fever habitual, and caused by sanitary defects. Drinking water found polluted. Privies badly constructed; excrement accumulating in enormous cesspools. No proper system of sewers.
Stevenage - - - (Herts.)	1873	Regis.-General's Return.	Hitchin rural sanitary authority.	*Dr. Thorne.* Frequent prevalence of enteric fever. Very imperfect conditions of sewerage and drainage. Polluted water. Want of proper means for the disposal of excrement and refuse. Dilapidated cottage property.
Stowmarket - - (Suff.)	1871	Regis.-General's Return.	Local board - -	*Dr. Corfield.* Town generally clean. Water probably polluted. Filthy condition of new parts and suburbs of town.
Sunderland - - (Durham.)	1871	Regis.-General's Return.	Local board - -	*Mr. Radcliffe* Epidemics of typhus, enteric fever, and small-pox. Overcrowding. Defective drainage. Improperly regulated waterclosets, and generally imperfect and insufficient arrangements for preventing excremental nuisances. Defective water supply to tenemented houses.
Sutton-in-Ashfield - (Notts.)	1873	Regis.-General's Return.	Sutton local board -	*Dr. Harries.* Frequent prevalence of enteric fever. Wells exposed to pollution by surface drainage. Sewers unsuitable and insufficient. Improper system of sewage disposal. Insufficient privy accommodation. Nuisance from overflowing privies.
Sutton Veny - - (Wilts.)	1872	Memorial from vestry.	Sutton Veny vestry. Warminster guardians.	*Dr. Airy.* Epidemic of scarlatina and some enteric fever. Want of isolation of sick and of disinfection. Bedrooms ill-ventilated. Nuisances from privies and pigsties.
Swanage - - - (Dorset.)	1872	Report from guardians.	Guardians, Wareham. Vestry, Swanage.	*Dr. Home.* Enteric fever. Nearly all the inhabitants drink water exposed to pollution by sewage. No system of public sewerage except at Durlston Park. Accumulations of excremental matter and house refuse near dwellings. Insufficient privy accommodation. Scavenging wanted.
Swinton - - - (Yorks.)	1872	Local information.	Rotherham rural sanitary authority.	*Dr. Ballard.* Enteric fever endemic. Nuisances. Soakage of excremental filth into wells. No proper arrangements for disposal of excrement and removal of nuisances.
Tamerton Folliott - (Devon.)	1871	Representation of Plympton guardians.	Vestry - - - -	*Dr. Hunter.* Defective privy system. Pollution of drinking water.
Tenby - - - (Pembroke.)	1870	Regis.-General's Return. High mortality from fever.	Tenby local board.	*Mr. Radcliffe.* Prevalence of enteric fever. Water supply insufficient, perhaps locally polluted. Sewers unventilated. Bad system of excrement and refuse removal. Ill-kept fish market.
Torpoint - - - (Cornwall.)	1871	Local informatiou.	Anthony vestry - -	*Dr. Hunter.* Serious prevalence of enteric fever. Great want of water. Sewage nuisances in consequence.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Tottenham - - - (Middlesex.)	1873	Regis-General's Returns.	Local board - -	*Mr. Radcliffe.* Serious outbreak of enteric fever. High rate of mortality from fever and diarrhœa. Absence of proper ventilation of sewers. Water supply contaminated with decaying animal refuse. Ill-designed cesspools in parts not sewered. Nuisance from watercourses and ditches used as sewers, and from large deposit of sewage mud at the sewage works. Flow of sewage from the sewers disturbed by flood in February; consequent effusion of sewage on the lower parts of the village, and the escape of sewer air into the houses on the higher levels.
Tredegar - - - (Monm.)	1870	Regis.-General's Return.	Bedwellty guardians -	*Mr. Radcliffe.* There had been a severe epidemic of fever, probably not less than 1,200 cases, mostly of relapsing fever, but with some typhus, in the past 12 months, in the families of labourers employed by the Tredegar Iron Co. Much overcrowding and very ill-constructed houses. Imperfect sewerage, and ill-kept privies and sewers, with insufficient water supply. Inefficient nuisance removal.
Trewalda - - - (Cornwall.)	1872	Regis.-General's Return.	Camelford guardians	*Dr. Home.* No drainage, privies, or system of excrement disposal. Polluted water.
Two Waters. (*See* Frogmore.)				
Wareham - - - (Dorset.)	1872	Report from guardians.	Wareham guardians	*Dr. Home.* Enteric fever and ague. Water supply insufficient and mostly unwholesome. System of sewerage very imperfect. Great want of privy accommodation. No proper system for removal of refuse. Many houses unwholesome from overcrowding and want of ventilation, and unfit for the residence of human beings.
Warwick - - -	1870	Regis.-General's Return.	Warwick local board -	*Dr. Buchanan.* Prevalence of enteric fever. The public water supply of the town scandalously filthy. Sewers inefficiently ventilated. Unsatisfactory arrangements for refuse and nuisance removal.
Wath - - - (Yorks.)	1872	Local information.	Wath improvement commissioners. Rotherham rural sanitary authority.	*Dr. Ballard.* Enteric fever. Water supplied by company contaminated by sewage and other filth. Wells polluted. Want of drainage.
Wellington - - (Somerset.)	1872	Local information.	Wellington rural sanitary authority.	*Dr. Blaxall.* Epidemic of enteric fever. Water liable to pollution. Imperfect sewerage and drainage. No system for removal of refuse. Nuisances from manure, pigsties, and slaughter-houses.
West Auckland - - (Durham.)	1872	Reports from district medical officer.	Auckland guardians. West Auckland vestry.	*Dr. Harries.* Prevalence of enteric fever and diarrhœa. Recommendations of previous report of inspector only partly adopted. No proper water supply. Soil saturated. Privies insufficient and badly constructed. Wells contaminated by surface drainage. Nuisances and overcrowding.
Whitchurch - - (Hants.)	1872	Report from Guardians.	Whitchurch guardians. Ditto vestry.	*Dr. Thorne.* Enteric fever. Water obtained from wells sunk in porous soil saturated with sewage. No proper system of sewerage. Nuisance from piggeries. Overcrowding in badly-built cottages.

Places.	Date of Inquiry.	Ground of Inquiry.	Authorities concerned.	Inspector, and the chief facts reported by him.
Whitehaven - - (Cumb.)	1870	Regis.-General's Return.	Whitehaven local board.	*Dr. Buchanan.* Severe epidemic of true typhus. Enteric fever constant. Radically bad construction of the poorer quarters of the town, with much filth, destitution, and overcrowding. Wide-spread fouling of earth and air with excremental filth. Neglect by the local authority of many of its sanitary functions.
,, 2nd report.	1871	Information of constant prevalence of fever and unsatisfactory answer from trustees as to action taken on report of last year.	Town and harbour trustees.	*Dr. Buchanan.* Sewer system incomplete and ill-ventilated. Neglect as to privy accommodation, drainage, and scavenging. Defective ventilation of courts and houses. Overcrowding.
Wigan - - - - (Lanc.)	1870	Regis.-General's Return.	Wigan local board -	*Dr. Buchanan.* High rate of mortality, especially from fever and diarrhœa. Local want of sewer. Extensive nuisance from very ill-constructed middens. Want of privies and means of refuse removal. Bad construction and dirtiness of lanes, courts, and houses. Overcrowding. Inefficient sanitary inspection.
Wincanton - - - (Som.)	1872	Regis.-General's Return.	Wincanton vestry. Do. guardians.	*Dr. Home.* Continued prevalence of fever, chiefly enteric. Foul privies and drains. Air and soil polluted by sewage. Cesspits; water supply from reservoir polluted.
Worksop (town) - (Notts.)	1871	Regis.-General's Return. Report from Worksop guardians.	Local board - -	*Dr. Harries.* Scarlet and enteric fever prevalent. No proper water supply. Very bad privy arrangements. Numerous nuisances.
Worksop Union, without the district of the local board of health.	1871	Do.	Worksop guardians and various vestries.	*Dr. Harries.* Frequent prevalence of fevers and diphtheria. General sanitary supervision wanting throughout union. Almost everywhere want of proper water supply and due excrement removal. Gross neglect of matters in some places, and no system of isolation or disinfection.
Wycombe - - - (Buck	1870	Report of vaccination inspector.	Chipping Wycombe parish local board. Chipping Wycombe borough local board.	*Mr. Wagstaffe.* High mortality from scarlatina and other fevers. Drainage and sewerage defective. Serious want of privy accommodation. Water supply scanty, and largely contaminated by excrement. Combined action of the two authorities recently obtained.
Ystradgunlais - - (Brecon.)	1873	Regis.-General's Return.	Neath rural sanitary authority.	*Dr. Harries.* Serious prevalence of enteric fever. Polluted water. General want of privy accommodation. No proper means of isolating cases of infectious disease. No arrangements for removal of house refuse.
Ystrad-y-fodwg - - (Glamorgan.)	1870	Local information -	Pontypridd guardians. Ystrad-y-fodwg vestry.	*Mr. Radcliffe.* Great prevalence of enteric fever. Extreme neglect of all sanitary precautions. No due provision for excrement or refuse disposal. Water supply insufficient and liable to pollution.

No. 2.

Report by Dr. Blaxall, on an Outbreak of Enteric Fever in the Town of Sherborne, Dorsetshire.

The town of Sherborne is situated in the north-west of Dorsetshire, and, according to the census of 1871, contains a population of 6,041. Agriculture forms the chief occupation of the male portion of the inhabitants; but there are three silk factories, which furnish employment to a few men and boys and to about 600 women and girls. Glove-making is also carried on by the women in their own homes. The Local Government Act having been adopted some years since, the sanitary authority of the town is the Local Board of Health, who, about a month or six weeks ago, appointed Dr. Williams medical officer of health.

Sherborne stands on the south side of a hill which rises to a height of about 140 feet, and is of oolite formation; its surface generally is covered with gravel, but in some places the rock crops out.

In 1867 Sherborne was visited by an epidemic of enteric fever, which caused six deaths; since then enteric fever has been endemic, and recently it has been again epidemic, as is shown by the following table of mortality :—

Year.	"Fever."	"Typhus."	"Typhoid."	Diarrhœa.
1868 - - - -	1	—	—	5
1869 - - - -	—	2	—	4
1870 - - - -	2	—	2	6
1871 - - - -	—	3	5	2
1872 - - - -	1	—	1	2
The first 4 months in 1873 -	—	1	13	2
Total - - -	4	6	21	21

Sanitary Arrangements.

House accommodation is deficient, and overcrowding exists to a considerable extent. Many of the cottages require whitewashing and cleansing. No organised provision exists for the removal of house refuse, which is therefore suffered to accumulate in the neighbourhood of the cottages.

The removal of excrement is mainly effected by means of water-closets, many of which are in a very defective condition, and frequently one closet is used by three, four, or even more families. The water-closets are situated chiefly outside the houses, and are of two kinds; the one fitted with a cistern and ball-cock, and the other without any cistern. In the latter kind, water, when there is any, is supplied by a pipe which opens direct into the pan, and the water is turned on by means of a tap. The pan has a siphon-trap, which connects it with the soil-pipe. Many of the closets have no water laid on; in others, the tap of communication is broken or out of order. In the town are several privies with large pits, some open, others covered in, but all that I saw were in a filthy state, producing soil saturation and atmospheric pollution.

The sewerage and drainage are very inefficient. The channels used for carrying off slops and excrement are glazed earthenware pipes. Formerly the attempt was made to convey along these pipes the storm or surface water in addition to the sewage; the consequence was that the

contents of the drains burst through the traps, and flooded the floors of the houses situated in the low level of the town. Most of the surface water is now removed by an old drain and by separate pipes into the river. Sewage, with some roof-water, passes into the pipe system. The pipes appear to be still in some instances not sufficiently large for their purpose. Thus, a nine-inch pipe only is provided for the sewage of Cornhill, Newall, &c., and into this some four or five six-inch pipes open; these latter, themselves sometimes full, having also a steeper incline than the nine-inch pipe. The surface openings of the drains are usually trapped, and there are certain fixed ventilators to the sewers; but as there is a general complaint of the offensive smell arising from the drains and sewers, it would seem that the trapping must be defective or the ventilation insufficient, or probably that both these defects exist. Overflow and bath pipes appear, in some instances, to communicate directly with either soil-pipes or drains. In addition to these sources of danger, there are in the town remains of old sewers and dead wells, which give notice of their vicinity by the stench arising from them. I was present when one of these sewers was being opened and cleansed, and can therefore bear witness to its foul condition. In another instance I saw the floor of a house flooded with sewage supposed to have escaped from one of the old sewers; but the cause was not ascertained during my stay.

All the sewage of the town is emptied into the River Yeo, and causes great pollution of the stream.

The public water supply is derived from two sources. The first is in the valley at Castleton, about half a mile from the town, where a well is sunk to a depth of 130 feet; through the lower 90 feet iron tubes are passed, and as the water rises to the surface of the tubes, it is pumped up to the reservoir by the conjoint power of steam and water. The second source is a spring at Dymore; shafts are sunk, and the water is conveyed by a glazed earthenware pipe, laid at an average depth of $2\frac{1}{2}$ feet below the surface, until it arrives at the valley, where the earthenware pipe gives place to an iron one, which is also carried underneath the ground until it reaches the reservoir, making a total distance of about one mile and a half. The water from both these sources together is called the Board of Health water. As delivered from the reservoir it is believed to be of good quality. The reservoir (which receives the water from both sources) is situated at an elevation of 140 feet, *i.e.*, a few feet above the houses of the highest level of the town. It is well-built, cemented, and properly covered in, and its overflow pipe does not communicate with any sewer. The water is conveyed from the reservoir direct to the town by a six-inch iron pipe, which is then extended by branches in every direction throughout the town; connected with these branch pipes are leaden ones, which distribute the water to various courts and houses, and also convey water to closet-cisterns, or direct into closet-pans. In addition to the public supply, there are several wells in the town, which are exposed to contamination from the soil, occasioned either by privy-pits, or by leakage from the old sewers before mentioned.

In the absence of service cisterns to waterclosets, it results from the above described relation of water-pipe to soil-pan that there is serious risk of water pollution. This will be illustrated in the sequel, when the recent distribution of fever comes under consideration. In one instance, where a cistern was provided, I observed that drinking water was derived from the overflow pipe of a cistern which supplies two closets, an arrangement that results in the water becoming exposed to any sewer air that may pass up the pipes leading to the pans of the closets.

History of recent Fever Epidemic.

The history of enteric fever in Sherborne, and of the present epidemic in particular, is highly interesting. As has been already stated, enteric fever was epidemic in 1867, and has continued endemic ever since, doubtless through the means of atmospheric pollution arising from foul privy-pits and from ill-ventilated sewers and defective drainage on the one hand ; and, on the other hand, through the water used for drinking having been contaminated by sewage or sewer air.

The accompanying table shows the progress of the recent epidemic :—

Number of New Cases of Enteric Fever.

In the month of December 1872 - - -	2
„ January 1873 - - -	12
„ February 1873 - - -	15
In the week ending March 8th - - -	73
„ „ 15th - - -	45
„ „ 22nd - - -	28
„ „ 29th - - -	17
„ April 5th - - -	17
„ „ 12th - - -	23
„ April 19th - - -	2
„ April 26th - - -	6
„ May 3rd - - -	—
„ May 10th - - -	3
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It will be observed that rather numerous cases occurred in January and February ; that in the first week in March there was a sudden and very great increase, and during the remainder of the month a gradual diminution. I made careful inquiry into all the conditions likely to affect the health of the community, particularly with respect to the supply of articles of general consumption. The influence of milk in the distribution could be excluded, but respecting the circumstances of the water supply the following facts were ascertained :—During December 1872 and January 1873 the water was frequently shut off from the town at a point near to the reservoir, and the same thing was done every night in February. It is known that when the water was thus shut off there were certain delivery pipes up which there was a rush of air immediately the tap was unscrewed. Now many of the openings to the pipes, as before described, are situated in the pans of the waterclosets. At night, after the closet had been used, the tap would be turned on for the admission of water ; none flowing, the tap in many instances would not be turned off again ; thus a direct passage into the water mains would be left open ; but the accidental circumstance of leaving the tap open was not required, as many taps were broken, and admitted a continuous flow of water during the day, but at night, no water being present, were uninterruptedly open to sewer air. Through these openings, during the night, air commonly passed from the closet-pan to the water-pipe ; in other words, the system of pipes for the water supply became the means of ventilating the closet-pans ; if a trap happened to be broken or out of order it became a means of ventilating the sewers ; and if a pan happened to be full of excrement, that excrement would be sucked into the water pipe. In January and February, when there were at least 27 cases of enteric fever in the town, closet-pans thus circumstanced were doubtless in some instances tainted with the specific *contagium* of

enteric fever ; some may even have been filled with excrement from the bowels of fever patients. The sewer air which entered the pipes at night, when the water was turned off, would in the morning, when the water was turned on again, be driven forward, washing the pipe surfaces on which foul air had for hours been resting, and could hardly (even supposing no actual excrement to have got into the pipes) have failed to contain fever contagium ; and this water went on, not only to cleanse closet-pans, but to be drunk by the people in the town.

I think it probable that the recent outbreak of enteric fever was caused by persons drinking of this contaminated water, and I base this opinion on the following considerations : first, the sudden appearance of so many cases in the first week in March, *i.e.*, after the water had been shut off every night in February ; secondly, by the gradual diminution of cases after the first week in March, during which month the water was not turned off at nights ; thirdly, by the manner in which the cases were scattered about the town ; lastly and mainly, by the fact that the proportion of cases occurring amongst persons who derived their water from the Board of Health supply was much greater than amongst persons who had their water from other sources, as will be seen by reference to the following tabular statement :—

Houses in Sherborne, 1,010 :—
780 supplied with Board of Health water :
whereof were attacked by fever, 148, or 19 per cent.
230 supplied with other water :
whereof were attacked by fever 13, or 5·6 per cent.
Persons attacked between December 1 and May 10 :
In the 780 houses, 226, or 29 cases per 100 houses.
In the 230 houses, 17, or 7·4 cases per 100 houses.
Persons attacked in the first fortnight of March :
In the 780 houses, 111, or 14·2 cases per 100 houses.
In the 230 houses, 7, or 3·0 cases per 100 houses.

For the information on which the above statement is based, I am indebted to the medical practitioners of Sherborne, more particularly to Dr. Davies and to Dr. Williams, medical officer of health, who afforded me every assistance in their power.

Recommendations.

Having already furnished the sanitary authority with the departmental circulars on disinfection, &c., and recommended the measures to be adopted to prevent further spread of enteric fever, it remains for me to point out what is required to improve the sanitary condition of the town, and so provide against a recurrence of preventible disease :—

1. The law should be systematically enforced for the repression of overcrowding, and for the maintenance of all cottages in a cleanly and wholesome state. Dust-bins should be provided for the reception of house refuse, and public arrangements should be made for such refuse being periodically removed to some locality sufficiently distant from the town to prevent any nuisance to dwelling-houses.
2. In place of the present privies with large pits, some other method for excrement disposal should be substituted ; all cesspools should be abolished. As there appears to be little or no doubt that a sufficient quantity of water can be obtained, the system of water-closets, already largely in use, would appear to be capable of

extension to all houses in the town, and to be the best adapted to its particular circumstances. The sanitary authority should see that all closets are supplied with water and kept in perfect working condition; that the soil-pipes of all closets are properly trapped and ventilated, and that each closet is supplied with a proper service cistern, so constructed as to give a proper flush of water, and to prevent any communication between the closets and the pipes which supply the drinking water. The number of waterclosets should be increased, so as to meet the necessities of the several families using them.

If waterclosets are not everywhere adopted, the authority must see that the means of excrement disposal are such as not to be a nuisance. The present pit-privies might be replaced by earth-closets or pail-closets, the authority undertaking the regular and systematic removal of the contents. For information on this subject see the departmental report on "Certain Means of preventing Excrement Nuisances in Towns and Villages."

3. The sewerage should be improved by the abolition (with proper precautions in the process) of all badly constructed or disused sewers and drains, and by the construction of efficient new sewers and drains wherever required. All sewers should be fully ventilated, so as to prevent the accumulation of sewer air, and means should be provided for periodically flushing them.

   Within houses all inlets of drains should be thoroughly trapped. Overflow-pipes from cisterns and waste-pipes from baths should not be in direct communication with any drain, but should be led over a drain entrance outside the house.

   Some means will have to be adopted for the disposal of the sewage, as it will not continue to be allowed to drain into the River Yeo.

4. The water supply should be increased, so that a continuous supply may be delivered; and great care should be taken to protect the water used for drinking and domestic purposes from all chance of contamination.

   All wells situated in the vicinity of drains, cesspools, &c., should be closed. In the central parts of the town there can be few wells that do not run risk of pollution from these sources.

5. A skilled engineer should be consulted as to the best means of improving the sewerage, and providing the town with a continuous supply of water, &c.

6. It is much to be desired that a permanent hospital should be established for the reception of persons suffering from dangerous infectious disease, in order that whenever a case appears, ready means of isolation may be at hand for such persons as cannot be properly lodged at home. On this subject the authority may usefully consult the departmental memorandum "On Hospital Accommodation to be provided by Local Authorities." In connexion with this hospital a suitable carriage should be provided for the conveyance of patients.

7. A proper chamber for disinfecting clothes, &c., should be provided, and other means of disinfection should be used about the persons and in the houses of people attacked by infectious fever. It is of particular importance that the bowel discharges of enteric fever patients should be duly disinfected before being thrown away.

P.S.—With respect to the rural district of Combe, a suburb of Sherborne, where enteric fever is endemic, it is important that the attention

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Enteric Fever at Sherborne, by Dr. Blaxall.

of the rural sanitary authority, which is the Sherborne board of guardians, should be directed to the unwholesome conditions which abound in that neighbourhood :—

1. The water of "Combe Brook" is exposed to contamination from a privy built immediately over it, also from the droppings of cattle in the immediate vicinity of the spring where the brook has its origin, and from the drainage of Combe Farm.

2. In the neighbourhood of the cottages are large privy-pits, which cause the soil to be saturated, and the atmosphere to be polluted with excrement.

3. The large cesspool which receives the drainage from the closets of Mr. Mitchell's new houses is an abominable nuisance to the neighbourhood.

4. A filthy privy-pit extends under the footpath near the turnpike-gate, and is very offensive.

Steps should be taken to protect the water of the brook from contamination, the large privy-pits and cesspool should be abolished, and such a system of excrement disposal provided as shall not be fraught with danger to the public health. The report "On certain Means of preventing Excrement Nuisances in Towns and Villages" will give the authority suggestions for obtaining improved arrangements in the last-mentioned respect.

No. 3.

Report by Dr. Buchanan on an Outbreak of Enteric Fever in Caius College, Cambridge.

In the town of Cambridge, since Midsummer last, enteric fever has been more than usually prevalent. In July one death from fever was registered, and six cases were admitted into Addenbrooke's Hospital from various parts of the town. In August three cases were admitted to the hospital, and in September two fresh cases were received into the hospital and there was one death in the town registered from fever. In October the disease became still more prevalent and fatal; especially, as the books of registrars and of the hospital show, in the neighbourhood known as Barnwell. In the three months, October, November, and December, the fever mortality in the whole registration district of Cambridge reached 15 out of a population of 30,000, being at the rate of 0·5 per 1,000 residents. The district has four registration sub-districts, and of these the sub-district of St. Andrew the Less was, after correction for the disturbing effect of the hospital, the one which in these three months had the highest fever mortality: here fever caused 0·69 deaths per 1,000 residents. In the other sub-districts, which have many sanitary advantages over St. Andrew the Less, cases were more scattered, and the deaths in the three months, including the deaths at Caius College, were at the rate of 0·28 per 1,000 only. The fever was at first wholly among the townspeople. In November it appeared in Caius College, and developed into the outbreak that is the subject of the present inquiry. But during the whole fourth quarter of last year, and up to the date of my visit (January 17–24) no other college has had any case of fever, unless a rumoured single case at Queen's be an exception.

In Caius College a case, the nature of which can perhaps not be affirmed with complete certainty, but which seems almost certainly to have been one of enteric fever, and, if so, the first case of the disease, occurred on the Library Staircase at the north-west angle of the college. The patient was a student who had come into residence on October 7, and his first symptoms date from November 1. The circumstance that at that date, and for a week after, there was no other case of enteric fever in the college, taken along with the circumstance that almost all the sanitary arrangements of this part of the college are distinct from those of the part afterwards and most severely attacked by the fever, lends support to the view taken by Dr. Paget and Dr. Bradbury, that the cause of that first case was not the cause which afterwards produced the more general outbreak. The second case of the fever, and here there is no doubt of the nature of the disease, occurred on November 8, on Staircase R, in Tree Court. The next cases were three, all on the same day, November 15, occurring in students living on Staircases O and S, and in the servant of a student on Staircase R, all of Tree Court. On November 18 a second student on the Library Staircase was attacked, and on the 19th a student living on Staircase N of Tree Court. From this time other students fell ill of the fever, some of them after the day of leaving college for the vacation, but all of them before the 1st day of December. The total attacks of fever among the students numbered 15. There was also one attack, before mentioned, and only one, among the students' servants. These students' servants live in various parts of the town, and between November 20 and 22 four attacks of fever in their

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Enteric fever at Caius College Cambridge.

children came under medical observation: another child of a student's servant was attacked in December. No case of fever occurred in any Caius student living in lodgings in the town.

The following is a tabular statement of the number of persons of each class referred to, and of the number of fever cases among each class. The first section gives the facts for Caius College and its various parts; the second section for persons more or less connected with the college; and the third section gives some general data for comparison. This Table shows the attacks in each class during the three months, October, November, and December 1873. It has not been found necessary to exhibit here the fact of the Caius fever being in one of these three months only.

Occupying Rooms.	Persons.	Fever Cases.
§ I.—		
In Caius College - - - - -	112	15
In Tree Court - - - - -	63	12
In Gonville Court - - - - -	17	1
In Caius Court - - - - -	13	—
On Library Staircase - - - -	8	2
In Master's Lodge - - - - -	11	—
§ II.—		
In town lodgings: students - -	51	—
In town houses: students' servants - - -	34	1
,, kitchen servants - - -	7	—
,, housemates of students' servants -	60	5*
§ III.—		
In 105 houses in neighbouring streets - - -	(?)525†	8‡
In houses throughout Cambridge - - -	30,000	150§

* Five cases in three families.

† This figure is obtained by estimating five residents at each house whereat inquiry was made.

‡ This figure ought perhaps to be 9, but 8 having been obtained by the means of investigation adopted, it has been thought best to keep exactly to the results of that investigation, and not to correct them by other knowledge that could not be uniformly applied.

§ This figure has been obtained (in the absence of sickness records) by reckoning 10 cases to have occurred to every registered death. The estimate accords sufficiently well with the results of a private inquiry made at the end of November, when 46 cases were heard of in the town practice of 9 medical men. The Urban Sanitary Authority has had no medical officer of health, and it made no inquiry into the extent of the disease till the end of January. Then 9 cases only were returned as being under treatment in the town.

The main facts shown on this Table are—first, that the fever attacked Caius College with a very special incidence; secondly, that it has attacked the students resident in college, and not the residents in town lodgings; thirdly, that it has attacked various parts of the college with various degrees of violence.

The Rev. N. M. Ferrers, tutor of Caius College, has kindly investigated for me numerically the *a priori* probability of these and some other facts to which reference will be made in this Report, and has thus made more trustworthy the statements that will be made respecting the peculiarities of incidence of the fever.

1. As for any notion that the observed incidence upon the college may have been due only to the same causes that produced fever in other

infected parts of Cambridge, it may be at once dismissed as entirely out of the question.

2. The incidence of 15 cases of fever being wholly upon the 112 students resident in college, and not at all upon the 51 students resident in town lodgings, makes it probable that the cause of the fever will not be found in any condition common to the two classes of students. Reckoned from the above figures, the chances that the cause will be found in some condition peculiar to the class of college residents are 375 to 1.

3. It will be seen by the Table that the distribution of fever in the several localities within the college has been very uneven. What follows on this subject, and in regard to causation, should be read with reference to the annexed ground plan of Caius. The several courts, "staircases" ("staircase" is the name for what is in fact a house, having a common stair, and a number of two-roomed tenements approached from the stair), and other parts are here shown, and the various drains, sewers, and water pipes in and around the college. Gonville and Caius Courts and parts to the west of them are old. The library and its staircase (F) in the north-west corner of the college were built some 20 years ago; but Tree Court (that is, all the buildings lettered from N to V, inclusive), with the portion of the central building north of the chapel (this portion being reckoned to Gonville Court) was erected only four years ago. Throughout the college a supply of excellent water from the waterworks company is delivered on the "constant service" plan; great care has been taken about other sanitary arrangements, and, except for casual oversights, they are excellent. But in the new buildings, at the time of their erection, such an amount of care and thought was bestowed upon the structural arrangements that it has appeared almost impossible for any injury to health to occur from mischances of sewers, drains, or water pipes. With an exception or two, to be discussed hereafter, the rule in Tree Court is that there is no sewer or drain underneath any part of any building; that there is no opening within any building to any drain; that the water-closets are isolated, of approved construction, and that every excrement-carrying drain takes the shortest cut into the environing sewers outside the college. The drains within the area of the court are mere pipes for slops and surface water, trapped in their course. And the rain-water pipes from the sides of the Tree Court buildings enter the sewers through 9-inch pipes, in each of which a trapping bend (commonly known as a "siphon," a misleading name, and not here used, as true siphon action will have to be spoken of) is provided.

In view of the special sanitary arrangements of Tree Court, it was not a little surprising and disappointing to observe the occurrence of case after case of fever here, and ultimately to find that out of the 15 cases of fever among the 112 residents in the whole college, no less than 12 were among the 63 residents in Tree Court. Now the chances against this event, as a matter of *a priori* probability, are 24 to 1, an odds so large as to make it necessary to seek the cause of the fever in some condition peculiar to Tree Court, and not operative or greatly less operative in other parts of the college.

In investigating the causes of enteric fever in Caius College, it has been necessary to hold all the foregoing facts in view, and to choose among various hypotheses of causation, that which best explains all the occurrences. In undertaking this task I was greatly helped by the fact that Dr. Paget, Regius Professor of Physic, and Dr. Bradbury, both of them physicians to Addenbrooke's Hospital, had gone over the ground

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of inquiry before me, and particularly that they had, after careful consideration, excluded several conditions that, *primâ facie*, had seemed causative of the disease. It appears desirable, however, in this Report, to discuss all conditions, whether or not they had been before considered, that can with any plausibility be regarded as causes of the fever, in order that the degree of credit to be assigned to each supposed cause may be represented in its due proportion.

The college is in a somewhat central part of the town, fairly elevated. Its soil is for 11 or 12 feet made-earth of the kind usual in old towns. Then follows a thin bed of dry gravel, exposed in digging the foundations of the new buildings, and existing probably at about the same depth over the whole site of the college. The only known exception to this gravel is a patch of clay of a few square yards at the south-eastern angle of the new building. Below these layers comes the gault clay. The foundations of the college reach down to the gravel and are all of concrete. This is very much the same kind of soil as other parts of the town in the neighbourhood of Caius.

Ever since July there had been an unusual amount of enteric fever in the town of Cambridge, and therefore no search was made for an independent *de novo* origin of it in Caius. It would have been impossible to certify with regard to any collection or derivate of excrement, or anything contaminated by excrement in Cambridge, that it had not had in it the contagium of enteric fever. The direction of inquiry, therefore, concerning the cause of an outbreak of this fever in November, has clearly lain in discovering how excremental matter of any description can have been presented to the lungs and stomachs of the persons attacked.

Searching through the college for conditions under which any such excremental matter can have been introduced, *Air*, contaminated by excremental products, comes first for consideration. Such air may be supposed to have conveyed the fever infection to certain students, either during their visit to water-closets or in their own rooms. It can hardly be supposed to have been more generally diffused than this, or some of the students living in town lodgings, who frequented the college by day, must have suffered.

The position of the various water-closets of the college is shown on the plan; those used by residents in Tree Court abut on the outer wall at the north-west corner of that court. All students' closets were found in good order and provided with efficient traps, the pipes from which pass into sewers in the streets around the college. Neither these pipes nor the outer sewers have means of ventilation; but in this respect the particular closets and sewers of and about Caius probably differ in no respect from the usual arrangements of good houses in the town. The closets for Tree Court are in an unwarmed, almost open, building; no bubbling up them is known to have occurred; and pressure of sewer air behind them, if there were such, would probably find readier means of relief than through the extra deep traps of these closets, well supplied as they are with water.

It may be suggested that the student living on the Library Staircase, and attacked on November 1, may about that date have visited, not only his own closet, but one of the closets assigned to Tree Court; that his visit to the former may, by leaving it specifically infected, have been the cause of fever to his neighbour using the same closet and attacked on November 18; and that his visit to some Tree Court closet may, by leaving some part of its structure specifically infected, have been the cause of fever to such students of Tree Court as afterwards visited that particular closet. Now, certainly, I have no data for deciding whether some accident of this sort did or did not take place.

Some such casual and temporary infection of a closet structure must be a matter of frequent occurrence wherever enteric fever exists. But experience tells us that, with anything like decent management of a water-closet, such an accidental infection of its structure is not followed by any series of events resembling those of November in this college. Hence I find it necessary to go further in search of some more special circumstance affecting the residents here.

As for the air of the students' rooms, so far as it enters by the door, it is the air of the staircase, where it were vain to seek for any excremental impurity, because, as before said, there is there no water-closet nor any sink or drain. Near the library staircase, indeed, a faulty drain was discovered in a coal cellar, but, as all the people employed in the kitchen, nearer to this cellar, escaped fever, the drain had probably no influence on more distant rooms. So far as the air of the students' rooms is admitted by the windows, it may, perhaps, have received, though with much dilution, some sewer impurity. Especially the suggestion has been made that rain-water pipes may have conducted sewer air into the neighbourhood of windows. In one place, again, by the library staircase before mentioned, certain rain pipes passed directly into and served to ventilate an excrement drain, conducting foul air from it to near a passage window of the staircase where the first attack occurred. In all other parts of the old buildings the rain-water pipes are connected with the slop drains within the court area. In Tree Court these pipes were arranged on another and a definite plan. Descending from the roof, and receiving on the second-floor level the rain from certain balconies, they passed down into special horizontal underground drains of 9 in. diameter, and these, always with a trapping bend near their ends, entered at several places into the foul sewers outside the college. It is asked whether some sewer air may not have bubbled through these bends, or whether in some way the trapping action of some one or more of them may not have been destroyed. The former accident may, here and there, under the conditions of insufficient ventilation of the sewers, perhaps have taken place, but it cannot be supposed to have occurred to any considerable extent or in any way peculiar to the college or to Tree Court. The latter accident is more important to consider, as the destruction of the trapping action would leave the upper openings of the rain-water pipes in direct open communication with foul sewers, and the supposed opportunity for foul air rising in quantity up the sides of the building might be thus afforded. Whether any emptying of the trapping bends did actually occur is a question that unfortunately cannot be answered, but the probabilities of its occurrence have been carefully thought out. First, the emptying of a bend is not likely to have occurred through evaporation, as the weeks at the end of October and beginning of November were cold and sufficiently rainy. Secondly, the emptying of a bend is not likely to have been effected by the aspirating action of any current in front of the bend, for the circumstances do not exist under which such action could be strongly exerted, and when it was most exerted (that is, when the street sewers were flowing rapidly with storm water) would be the time of best provision for keeping the bend full from behind. Thirdly, whether the trapping bend could on some occasion have been emptied of its water by a true siphon action, remains as a more difficult branch of the question. This occurrence must depend upon a variety of circumstances, and they are hard to formulate ; among them are the calibre of the pipes, the rate and quantity of flow along them, the incline of various parts of the pipe system, the completeness of air removal from the lower part of the

system, and, perhaps most importantly, the rapidity of cessation of the waterflow along the pipes. I have studied these circumstances as far as I am able for the particular case of the rain-water pipes at Caius during the period in question, and am disposed to believe (though I am not in a position to demonstrate) that here the trapping bends could not have been emptied by true siphon action.

Having regard, then, to every suggested sort of accident to the downspouts of Tree Court, it seems unlikely that they had any great amount of sewer air transmitted up them; and, as before observed, any such sewer air would, after its exit from the downspouts into the open air, be much diluted before it reached any window. On inquiry, further, as to the incidence of fever on the several stories of the new building, there does not appear much likelihood of foul air, conveyed in this fashion, having been a cause of the disease; for the attic and second-floor chambers of Tree Court, the chambers that had their windows nearest to openings in the downspouts, did not suffer more than the chambers on the first and ground floors, with windows away from any such openings.

Drs. Paget and Bradbury, who for a time had thought the hypothesis of atmospheric impurity the most plausible explanation of the facts, had, before my visit to Cambridge, recognised the unsatisfactory character of any such explanation; and had searched for other means by which the material of enteric fever could have been introduced into the college. The *Water* supplied to the college, being the same that is supplied to the greater part of the town, its quality having never been called in question, and the domestic supply of the college being on the "constant" system from the company's mains, was provisionally acquitted of blame, and the source of the college *milk supply* was diligently investigated. The premises of the milk seller were visited, but only ordinary cow-house faults were found there. There was no drainage nuisance, no water beyond the good water supplied by the company, and no person about the dairy had had fever. Still there soon appeared some *primâ facie* ground for suspecting the milk supply, in the circumstance that in the families of townspeople taking the milk of this dairy there had been a good many cases of fever. Out of an unknown number of people (but certainly more than 100 households) taking this milk, either directly or through Caius College, 16 attacks of fever were heard of at the end of November, and there might have been others not heard of. The exact significance of this circumstance as inculpating the milk could not be estimated; but, on the other hand, in opposition to the belief that the milk had played a part in the production of the fever, Drs. Paget and Bradbury pointed to the unequal distribution of the fever within the college, where all parts were supplied with the same milk, and they concluded that there was not sufficient evidence against the milk.

Making a fresh examination, on a somewhat different plan, of this question of *milk supply*, I had the assistance of Dr. Bradbury and of Mr. Harle, of Addenbrooke's. Mr. Harle kindly inquired throughout certain streets in the same quarter as the college, and gave me notes on 105 houses, as to their milk supply and as to any fever in them. He was informed that last October and November 13 houses got milk from the same dairy that supplied Caius, and 92 got milk from various other sources. Of the 13 houses three, he was told, had had cases of fever; of the 92 he could only hear of five that had been attacked.

It must be premised that the data themselves were known not to be precisely accurate, that at one house fever was denied and at another the fact of

two milk supplies being taken was suppressed, and so on. But this particular knowledge came from a special source, and could not be applied to correct the whole of Mr. Harle's results. And it was thought that worse fallacies might be introduced by making partial correction than by leaving the whole results just as Mr. Harle procured them.

Plainly there arises out of this inquiry a probability that the milk may have been at fault. On the other hand, consideration of the unequal distribution of the fever throughout the college constituted, as Drs. Paget and Bradbury had pointed out, a probability that the milk supply, a condition common to the whole of the college, was not at fault. I ascertained that all the college supply at each delivery was brought to the college gate in a single "tank," and was distributed by the same cans (refilled from the tank as often as necessary) throughout the various parts of the college. The milk, therefore, as supplied to the one or the other court, must have been everywhere exactly the same ; yet, in the distribution of the fever, persons living in one (Caius) Court wholly escaped. In deciding the amount of the one and the other probability, I had the advantage of Mr. Ferrers's aid, and find that the chances for and against the milk (so far as they rest on the foregoing data) are almost exactly balanced, being about as six to one on each side.

There is, however, much more important evidence forthcoming about the milk than is afforded by these comparatively small and conflicting probabilities. In a previous reference to the circumstances of resident and non-resident students, I have quoted Mr. Ferrers's calculation that the chances were no less than 375 to 1 that the cause of fever did not lie in a common condition shared by the residents in college with the residents in town lodgings. Now, the milk from the same dairy is supplied direct from the dairy to both classes of students ; there is no reason to suppose it is anywise different as delivered to the one and to the other class. This evidence is, to my mind, conclusive as acquitting the milk ; for whatever were the small presumptions against it, arising from the earlier inquiries, and now from those of Mr. Harle, they are wholly thrown into the shade by the consideration of the last-mentioned enormous degree of probability that it played no part in the fever.

All the more usual ways of enteric fever spread have now been considered, and none of them have appeared adequate to account for the intensity of incidence of fever upon Caius College, or for its remarkable incidence on Tree Court. Holding always in view the special character of these occurrences, let us refer again to the plan, and observe that the *water supply* to the college is taken from a surrounding 5-inch main at six different places, and that one of them, at the Gate of Humility, is for Tree Court, and for no part but Tree Court. What if there should be something wrong with this one local supply ?

Even *primâ facie*, there is something to be said for this view. The suddenness of the outbreak in the college was such as at once to suggest to Drs. Paget and Bradbury, and equally to myself, "the thought that it might be due to contamination of the water or milk." The area of the particular water distribution is exactly the area of the fever, at least of 12 out of 15 cases, one or more of the remaining cases requiring probably no explanation beyond every-day circumstances. The good character of the company's general water supply would not avail as an argument against a local contamination in a local service. And at an early period of my investigation I was struck with the circumstance that while every watercloset in the old part of the building was provided with a cistern proper to itself, the closets in the Tree Court buildings

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were supplied with water direct from the high-pressure constant-service pipes.

Supposing, I asked myself, that the water of the particular service to this court had, through a direct connexion with some closet, at some time got mixed with watercloset or sewer air drawn into its pipes, had we not here, in Tree Court and not elsewhere, a repetition, at least in essentials, of the conditions to which, at Sherborne, my colleague Dr. Blaxall last year distinctly traced contamination of water and consequent enteric fever of a very wide-spread and intense kind? I remembered, too, that Dr. Blaxall's observations were in accord with some experiences published about the same time by Dr. Carpenter, of Croydon.

In following up this clue, some very interesting and suggestive considerations soon appeared.

1. As matter of fact, most of the students' servants about the college, and notably those of Tree Court staircases, spoke of the occasional absence of water from their pantry taps. In Tree Court two or three servants said that after such an absence the water would come on "with a vengeance," "like soda water," evidently having become mixed with air with which the pipes had become charged. The failure of water was mentioned by some servants as occurring once a month or so; by others as being more frequent; and the servant having charge of the first floor and higher floors of Staircase O spoke of it as a thing that happened two or three times a week. Whence the air in these pipes may have been derived will presently be matter for consideration.

2. Under a really constant system of high-pressure water-service it is plain that pipes could not have thus got filled with air. Perhaps a considerable weakening of pressure, not going to the extent of intermission, might have stopped the supply at high levels; and there were particular circumstances to weaken the pressure in Staircase O, and these doubtless account for the more frequent lack of water here. But real intermission of supply must have occurred to account for the phenomena described. And this intermission must have gone to the extent of allowing the whole horizontal service main of Tree Court to have become emptied of water, if any hypothesis of mischief resulting from this air in the water pipes is to be upheld. For the fever attacked every staircase of the court from N to U.

3. Complete intermission of supply was found to have actually occurred on two occasions at least during the last term. The earlier occasion can be defined as the evening of the second day of an October frost; and, thus far might have been either on October 25th or on October 30th, but other associations suggest October 25th as being the more probable of the two days; on this occasion only the particular service through the Gate of Humility was stopped. The later occasion was when the water company's servants having, for purposes of pipe repair, cut off the water supply of some half of Cambridge, there was hurrying to restore the supply in order to gain water power to blow the organ of King's College Chapel for a musical service. This fixes the date of the second known intermission at about half-past 10 a.m. on All Saints' day, November 1st.

4. Now a fortnight is about the incubation time of enteric fever. A fortnight after October 25th is the date of the first attack in Tree Court. A fortnight after November 1st is the date of the second, third, and fourth attacks. And though it was known that other cases of fever kept dropping in till the end of November, the coincidence of the early fever with these ascertained intermissions was not the less suggestive as indicating the direction that further inquiry should take.

It has just been said that any hypothesis of harm coming from air mixed with the drinking water of Tree Court cannot be satisfied unless the whole horizontal service main of the court can have been emptied, An apparent physical obstacle to such emptying of this main was indicated by the water company. Admitting that the pipes of any particular staircase can be emptied, viz., when an upper and a lower tap are at the same moment open, the company points to certain taps (which I shall call "valve-taps"), that are placed on the water pipes at the bottom of every branch to every staircase, and elsewhere on water pipes in the college. These valve-taps are of peculiar construction. Their first object is to allow the supply of any particular sub-service to be cut off, and this is effected by a screw action. But when the valve-tap is completely open, it will not allow, or rather is not intended to allow, passage of anything along the pipe except in one direction, from the mains to the place of use. A plug placed inside the valve-tap and acting by gravitation, is the means by which the result is attained; and certainly, when one tests such a tap by blowing first into one end and then into the other, while the tap is open, it is found to give passage to air in one direction only. It was held, therefore, that the existence of these valve-taps at the foot of all staircase pipes would prevent any back flow of water or air into the horizontal main. Now to this it might almost be enough to oppose the experience of the servants respecting the quantity of air found in the pipes after an intermission of supply, but it was seen that if they had exaggerated the quantity, the air observed by them might have been merely what had got into the particular staircase pipe during an intermission of service, and the tap at the foot of the staircase might still, by its automatic action, have effectually prevented any back flow of air into the horizontal main. The question was put to the test of experiment, with the kind help of the water company. While the pantry tap on the topmost floor of Staircase P was being kept constantly open, and the taps on other floors of the staircase kept shut, the whole of the water mains in and around the college were emptied at hydrants and elsewhere. If the automatic valve-tap at the foot of the Staircase P had done its duty, obviously the water would have been held up in the pipe of that staircase. But in fact it was found that as soon as water ceased to flow from the high-level pantry tap, air was sucked into it with considerable force, and on proceeding to turn other taps at lower points of the staircase, not a drop of water escaped, proving that the water had all passed backwards through the supposed automatic valve-tap into the horizontal main, and that this tap had not had the slightest influence in preventing the accident which it was designed to prevent. In justice to the principle of the valve-tap, however, it must be added that this particular tap was laid on its side in such a way that gravitation could not move its internal plug. This blunder had perhaps been made elsewhere, but the fact of this particular valve-tap on the service pipe of Staircase P offering no obstacle to the reflux of air into the horizontal main, will hereafter be seen to have a special importance.—On restoring the water supply, water mixed with air rushed out of the top pantry tap with much force and splashing.

It must be remembered how Drs. Paget and Bradbury saw, in the circumstances of the particular outbreak in the college, reason for suspecting that the fever poison had been introduced by some article of drink, and it must be admitted that of an equal number of persons drinking dangerous water and breathing dangerous air, the former are likely to suffer in the larger proportion. Although, among the users of some particular well in Cambridge, a special incidence of fever may have existed, yet, *among people taking the company's water*, it may be almost certainly affirmed that nowhere in Cambridge was the same sort of risk incurred as at Caius College for dangerous matters getting introduced into drinking water.

It is the rule with the Cambridge Water Company to supply water-closets, not directly from the high-pressure pipes, but from an interposed cistern or service box. This arrangement, besides preventing waste of water, has the following advantages: that, if there should ever be any foul vapours from a watercloset, and these should under any circum-

stances pass through the closet supply valve, their passage backwards along the water pipe must be interrupted at the cistern or service box. The omission of this arrangement, on the other hand, affords a risk of such vapours passing directly into other parts of the water system, if they should succeed (on occasions when the closet valve is opened during intermission of water pressure) in passing through the supply valve of the closet. At Caius College this risk was run, and it will presently be seen that air from a watercloset, passing through the valve on the service pipe, had opportunity of reaching other pipes which supplied drinking water.

The rule that every watercloset shall receive its water supply through a cistern or service box is so generally observed in the colleges and houses supplied by the Cambridge Water Company, that at my first visit to the town, I found the company was unaware of any exceptions to the rule beyond those at Caius College. I afterwards found two other institutions where there was similar direct supply, and these will hereafter have to be mentioned. But for the present it will be sufficient to say that in them there was not the same sort of risk as at Caius for dangerous matters getting introduced from waterclosets into drinking water.

It has been said that Tree Court and Tree Court only, out of Caius College, presented the arrangement of waterclosets served direct from the high-pressure pipes. In the other parts of the college, the waterclosets were provided with cisterns or service boxes in the way usual in the town at large. Hence Tree Court was the only part of the college that ran the risk incidental to the omission of these arrangements.

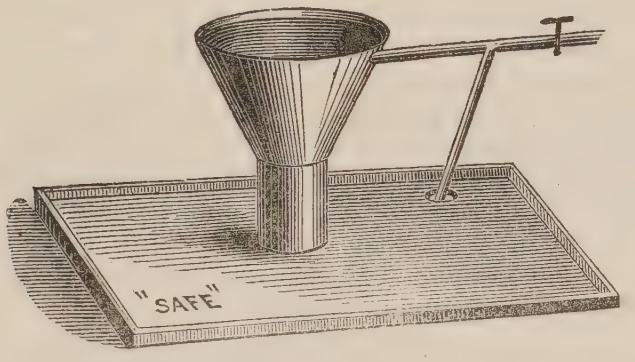
The closets of Tree Court are (*a*) those, before spoken of, at the north-west corner of the court; these have no interest for us as affecting drinking water in the college, since they are served directly from the 5-inch main in the street, by a branch which furnishes no drinking water to the college. And (*b*) two closets within the Tree Court buildings — closets directly connected with the service that enters through the Gate of Humility, and that furnishes drinking water for every staircase of the court, beginning with Staircase N, and ending with Staircase V. One of the two closets now under consideration is situated in the basement of the porter's lodge, the other on the first floor of Staircase P.

It is the last-named closet on which interest chiefly centres. It is some 30 or more feet of vertical distance above the level of the horizontal water main of Tree Court, and some five or six more feet above the level of the closet in the basement. This elevation obviously must have given particular facility for the entry of air into the service pipes of the Staircase P closet. When the pressure of water was intermitted, the supposed automatic valve tap at the foot of Staircase P failed, as we have seen, to fulfil its intention of preventing air from entering the horizontal main. On such an occasion it only needs the water valve of the upper closet to have been open or leaking, while in the basement the water valve of the closet or the tap over the adjoining sink (a screw tap and very liable to be left open) was also open or leaking, in order to cause the entire horizontal main of Tree Court to have become filled with air containing watercloset vapours, afterwards to be delivered in drinking water.

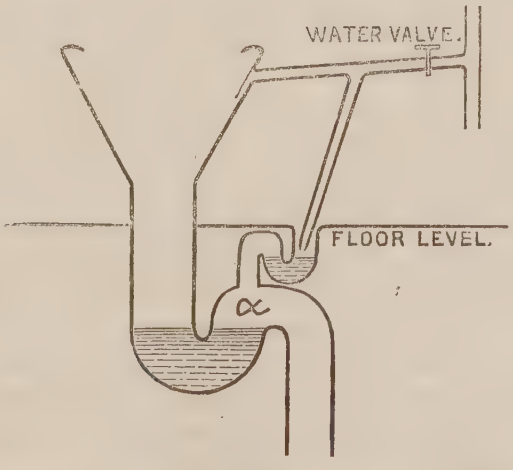
For the better understanding of the physical circumstances that may have operated to allow watercloset air to enter the Tree Court water system, particular examination has been made into the details of construction of the two waterclosets, and particularly of the upper one.

Both the closets now being considered must be suspected of having assisted, though probably in different ways, to a contamination of water in the Tree Court main. The chief way in which the lower closet and its adjacent tap would be likely to be mischievous on occasions of intermission of water supply would be that while they were open (as, from the facts about Staircase O, as well as from my own observation, it is certain they often were), they would permit exit of water from the pipe system of Tree Court, and consequent entrance of air into this system. This would occur whenever, under such circumstances, an opening was made at a higher level. In this way the whole horizontal main of Tree Court, between such higher opening and the basement closet, could be filled with air; and the effect of afterwards recharging this main with water would be to distribute the air, along with anything that was harmful in it, to every staircase of Tree Court. It is, I think, pretty certain that air from the basement closet itself could not have entered the water pipes through the half open water-valve, for there was no column of water at a lower level to draw air into the service pipe; and the arrangement of that pipe was such that air can hardly be supposed to have bubbled inwards into it, while water was trickling outwards through the water-valve.

The upper closet would probably play a more direct part, for it would certainly allow, when its water-valve was moved during times of intermission of water supply, free entrance of watercloset air, in replacement of the water between its own level and the basement. The woodwork of Staircase P closet had been removed before my first visit, and the arrangements shown in the following diagram (A) were exposed to view, an ordinary tray or "safe" being



on the floor level to catch an accidental splash or leakage; and a small pipe, the function of which was not at first apparent, leading from the service pipe to a hole in this "safe" after the manner here shown. The workmen who had removed the woodwork spoke of there being some filth (which they supposed to be excremental) in the "safe" in the neighbourhood of this hole. For the better understanding of this arrangement I had the "safe" removed, and found the closet to be of the S-bend pattern with details as shown in diagram (B). The small pipe from the water service was found to dip about three quarters of an inch into the hole that had been seen in the "safe," which hole was the commencement of a smaller S-bend pipe, provided to drain the safe (in case of



its being flooded) into the top of the great S-bend in the excrement pipe. Now from the unventilated sewer in Trinity Street, up to the point marked *a* in this diagram, there is not a single opening nor a single trap; nothing, either to get

rid of, or to attempt to keep back, the foul air. Due charges of water in the two traps were relied on to keep this sewer-air out of the general atmosphere of the building. It is intended that the closet, being in use as frequently and in the exact way that is expected, shall have its large trap kept filled by water down the pan, and the small trap kept filled by the small "weeping-pipe" that dips into the hole of the safe.

Now, assuming a closet of this construction to be in daily use, sewer air, as such, is not likely to pass through the great S-bend; though it is sure to become dissolved in the water of that bend, and to be given off, along with anything volatile it may have brought from the sewers, from the surface of water exposed at the bottom of the pan. But through the little S-bend it is not only in this way that we should expect air to pass from the sewers into the neighbourhood of the water pipes. A very small excess of atmospheric pressure in the downsoil pipe over the interior of the house would cause sewer air to bubble through the little bend; or some aspirating or siphon action, such as I think would be liable to occur, would empty this bend of its water. Sewer air, as such, finding its way to the water pipes would probably be more dangerous than sewer air that reached them after having been absorbed by and evaporated from water; for the latter sort of air could only contain volatile impurities, while the former would contain particulate elements as well; and it is probably in such elements that any specifically injurious quality of sewer air resides.

[If the closet be for any length of time out of use, the water of these traps evaporates, and is not resupplied; and so the whole staircase is in direct atmospheric connexion with the sewer. Probably this went on in the midsummer vacation, and was the cause of a stink observed on Staircase P, while this closet was locked up and deserted. But it is with no such accident as this we have to do. We are in search of some risk to the whole Tree Court *water* system through the operation of the closet.]

[In criticizing, as above, the construction of the Staircase P closet, I think it just to observe that that closet did not form part of the original plan of the new buildings at Caius, but was inserted while they were approaching completion; and further, that I learn on good authority that closets of this construction and others involving the same principles have come into increasing favour with many plumbers, who have regarded them as combining several sanitary requirements not attained in other forms of closet.]

It has been shown how readily the water pipes of the Tree Court may have got filled with watercloset air through the valve of the closet on Staircase P. From the construction of this closet, it is now seen that any such watercloset air *must have been essentially sewer air*, air from the pan containing sewer emanations coming through the water of the great S-bend, and, more importantly, sewer air (probably delivered exactly in the state in which it existed in the sewers) passing through the little S-bend up the weeping-pipe. Possibly too, not air only, but some liquid foulness may have been drawn up the weeping-pipe; for it dipped (as has been said) some way into the little S-bend, and hereabouts (we know from the workmen who first opened the closet) some filth was found. It is stated that a very rapid discharge of water down the closet-pan is apt to splash some of the liquid of the great bend (from the point marked *a*) up into the small S-bend, and even into the "safe."

Once again, any sewer emanation that is here in question may have had a specifically dangerous quality. As before said, no assurance can be given that this quality did not exist after July in any derivate of excrement in Cambridge. But we know more than this respecting the particular sewer into which the Tree Court closets discharged; we know that last October that sewer was actually contaminated, as it is not known to have been before contaminated, *with the specific matter of enteric fever*. "A short time prior to the appearance of fever in the college," Drs. Paget and Bradbury write, "cases [of enteric fever] occurred in houses on King's Parade and Freeschool Lane. . . . The town sewer, into which these houses are drained, passes along Trinity Street, so that the excreta of the fever patients must have been passing along

the sewer which runs parallel to the long front of the Tree Court. If, therefore, any emanations from this sewer could gain access to the college, they would be an abundantly sufficient cause of an outbreak of fever."

Later on in this inquiry, I thought it desirable that pieces of the water-pipes of Staircase P closet should be subjected to more minute, and especially to chemical examination. It was found that the outside of the end of the weeping-pipe, where this dipped into the small S-bend of the safe, was crusted with a brownish matter, uniformly, and as if gradually laid on; and this pipe and the supply pipe (taken from between the weeping-pipe and the water-valve) had inside them some little deposit not remarkable in its aspect. Dr. Dupré having these pieces submitted to him with a rough statement of the physical circumstances, was asked to make such an examination of them as he judged best, in order that an opinion might, if possible, be formed as to the presence of any fæcal product in the deposits, and he has given this significant report :—

"I. *Deposit inside the pipes.*—I cannot detect a trace of sulphide, and there is therefore no proof of the action of sulphuretted hydrogen. On the other hand the deposit, both in the supply pipe and in the small weeping pipe, contains a large proportion of nitrogenized organic matter and an appreciable amount of phosphoric acid, both of these in much greater proportion than could possibly be derived from the water used. It would seem, therefore, that *water* impregnated with fæcal matter must have entered these pipes and so helped to produce these deposits.

"II. *Deposit on the outside of lower end of weeping-pipe.*—In this deposit also I cannot detect any sulphide; but it contains, like the other, a very large proportion of nitrogenized organic matter, and a very considerable proportion of phosphoric acid. I cannot doubt, therefore, that this deposit is derived from water strongly impregnated with fæcal matter."

In Dr. Dupré's first paragraph I have put the word "water" in italics. His results show first, that (as circumstantial evidence had appeared to indicate) excremental matter actually has entered the water pipes of staircase P closet; and secondly, that it has in fact (what has before been suggested as a possibility), entered the water pipes as *a liquid*. In no other way can the presence of phosphates in the interior of those pipes be accounted for.

The "water impregnated with fæcal matter," of which Dr. Dupré speaks, came then from the closet traps, probably wholly from the little one in the safe. The trapping *water*, then, has been sucked into the water-service pipes. This has consisted of ordinary water-closet washings, but with the addition of anything it had absorbed from the sewer air with which it was in contact. So that if the consideration be of importance, it is now further seen that last October, *not only in air but actually in water*, fever poison may have entered the water pipes of Tree Court.

Attempts have further been made to learn something of the actual use of the Staircase P closet during October and November. As the closet is a private one, some interesting facts concerning it were almost beyond expectation available. It happened on a particular day, and in the evening of the day that something seemed wrong with the closet, for water did not flow into it after use. This day can be fixed as being in the latter half of October. The 25th was, it is believed, the day on the evening of which the service of Tree Court was cut off. The porter remembers that when he had cut off the water service on this evening he went down to his basement tap and collected there from all the water he could get for use till the service should be renewed. It is perfectly likely, therefore, that on October 25 there was a combination of conditions closely resembling those which I contrived (p. 7) in my experiment. Air was sucked into the pipes and distributed with the drinking water on both occasions;

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but on the October occasion this air was sewer air derived from the watercloset, and along with it, we may now believe, went some specifically infected liquid from the same source.

It is not, I think, possible to determine all the occasions when combinations of conditions, similar in essential respects to those of October 25, may have taken place, with the result of befouling the drinking water of Tree Court. Intermissions more or less complete of water service in that court would appear not to have been uncommon, and the circumstances of them are not now ascertainable. I have mentioned November 1 as one day when a complete intermission is known to have occurred, and have noted as a suggestive coincidence that the second, third, and fourth attacks of fever in Tree Court happened just a fortnight after. But I would not venture to affirm the exact relation of each water intermission to each case of fever. It is uncertain, for example, whether on November 1 anyone had access to the closet on Staircase P, and it is apparent that (if the closet-valve there did not leak, and there is no evidence of it having done so), there must have been somebody to move the valve of that closet in order that the particular mishaps of October 25 could have been repeated.

[It has been asked me why, if the closets in Tree Court buildings could have done harm by their relation to the local water service of Tree Court, those same closets, and also the closets at the north-west angle of the court, should not similarly have done harm to the district of Cambridge supplied by the outside 5-inch main, into which air from these various closets might be supposed to have got; if not at other times, at any rate on November 1, when not only one branch of the college water service, but the service of a very large adjacent area of Cambridge, was cut off. The question is an important one, as affecting the reasoning here adduced as to causation, inasmuch as the entry of sewer air into the 5-inch main should, on the present hypothesis, have been followed by fever outbursts elsewhere than in Tree Court—in other parts of Caius, in Clare College, in Trinity Hall, and other places, in most of which no case of fever was seen. The answer to the question is, however, clear. The engineer of the water company tells me that on November 1 no hydrant was open to drain the main; and even if one had been opened in the neighbourhood of Caius College it would have been impossible for the 5-inch main to have become emptied except after a considerable length of time, as there were several miles of pipes full of water at a higher level than the pipes surrounding Caius. In fact it was for a very short time only that the main service was cut off; long enough no doubt by removing the pressure to put a single service into the same condition as if its own junction with the street main had been severed, but not long enough to allow even a partial emptying of a street main fed by reflux of water from miles of pipes just above its own level. The physical conditions of the larger 5-inch main service were therefore different from the physical conditions of the particular Tree Court service, and no opportunity was given for the 5-inch main to get filled with air, either from sewers or elsewhere. The difference is represented, however, as being in some respects a question of time, and it is easy to imagine circumstances of open hydrants and longer intermission of service under which a much wider diffusion of fever might have happened in Cambridge—if the present hypothesis of its production at Caius be well founded.]

[I have, in a previous paragraph, spoken of two public institutions which have their closets supplied without the interposition of cisterns or service boxes, direct from the main, after the fashion of the closets in Tree Court. In neither of these institutions had there been any fever, and it was therefore with much interest that I examined the arrangements of these closets, to see how far they corresponded with those of Tree Court. In one of these institutions there are two closets in the basement, with construction and arrangements closely resembling those of the basement watercloset of Tree Court, of which closet, it will be remembered, I have written that it is very unlikely to have allowed air to pass backwards through its valve; and in this institution there was no closet at any higher level—nothing corresponding to the closet of Staircase P at Caius College. In the other institution there is a large group of closets of the same construction and arrangement as in the new closets at the north-west angle of the Tree Court at Caius; they have not had the opportunity, any more than the corresponding closets of Caius, of befouling any water

service. But there are here three closets on first-floor levels inside the building, served directly from water pipes which also supply some persons with drinking water. Special interest attaches to these three closets as regards their similarity to the closet on Staircase P of Caius, or their dissimilarity from it. They prove to be all of the same construction one with the other, and all in some essential respects different from the Caius closet. There is no "safe" to them, and therefore no weeping-pipe. They have traps of the D pattern, and in the trap there is no opening which would give exit of sewer air into the neighbourhood of any water pipe, or up which the trapping water could be splashed. The soil pipe is very amply ventilated below the closet trap, and between the foot of the soil pipe and the junction with the public sewer, first a trapping bend, and then a ventilating opening is placed. Of such a water-closet I would not certify that, on occasions of intermission of water supply, air might not be drawn from the closet pan into the service pipe; although, as automatic valve-taps, properly placed, are provided in connexion with the service pipe, this occurrence might not take place. But besides that the special risk of the weeping-pipe arrangement is absent, I would venture to affirm that if watercloset air was ever drawn into the pipes, it could not by possibility be *sewer air* in the sense that air from the watercloset on Staircase P of Tree Court must necessarily have been sewer air.]

There seems, then, ground for believing that on some occasions, under particular conjunctures of circumstances, excremental matter containing fever poison entered the water pipes of Tree Court, and was delivered along with the drinking water of the court. In this hypothesis, and in the course of the evidence that has been adduced in support of it, will be found a coherent explanation of the chief facts of the outbreak. We account for—

1. The special incidence of the fever on Caius College, and on the students resident there, as distinguished from the students living in town lodgings.
2. The special incidence of the fever on Tree Court, and its affecting all staircases and levels of Tree Court.
3. The date of the commencement of fever in Tree Court.

We have also perhaps accounted for other phenomena. For (4) if, as some competent judges contend, the incubation time of this fever may vary within somewhat considerable limits, not only the earlier attacks in Tree Court students, but some number of later ones, may be referred to *one or two* accidents of the sort discussed; possibly, some of such judges would say, even the whole of the attacks; though I should myself regard the latest attacks as more probably due to some repeated (if unknown) introduction of the fever poison. (5) A probable explanation is afforded of fever attacks in two out of three of the families of students' servants (see Table, p. 64); for very probably the jugs in which these two servants working in Tree Court sent home (as they were permitted to do) milk to their children were rinsed out with the same water that was used by the students. In these two families the attacks were nearly simultaneous with the group of attacks of November 15 in the college. To the extent of four cases in these two families, moreover, the relations which at one moment appeared significant as between milk and fever (in 16 cases) may be otherwise explicable. [Students resident in town lodgings received their milk direct from the dairy, as before said, and not through the college.] (6) The student who contracted fever while living in Gonville Court (Staircase G) frequently visited a student, who was attacked about the same time by fever on Staircase P, and he may thus have been subjected to the cause of fever special to Tree Court.

Reviewing, as judicially as possible, the whole history, both the facts of the outbreak and all suggested explanations of them, I am disposed to think the introduction of the fever, and the phenomena that were special about it—in fact for Caius College, *the cause* of the outbreak—*has lain in contamination of a particular section of the college water service.* I would not be understood to affirm that every case, even of

those in Tree Court, was directly due to that one cause and to no other ; but it would be safe to presume this, I think, for the great majority of the attacks. The apparent inadequacy of a cause so small and occult to explain such a large and crying misfortune will be to some people, I should suppose, a hindrance to an acceptance of this judgment. But in the pathology of enteric fever and similar diseases we know that a very minute quantity of infectious matter can, under favourable circumstances of distribution, produce very large and intense results. And, moreover, the present case does not stand alone as an instance of the spread of enteric fever by means of a so-called constant water supply that in practice has intermissions in its service.

At the time of my visit to Cambridge I found that means of ventilation, apparently efficient and safe, were being applied to all the college drains, and that all minor hazardous or suspicious conditions which had fallen under notice were being actively remedied. And now structural changes have been made by which, in every part of the college, it will in future be impossible for any drinking water to become impregnated by sewer air in the way in which it is here judged to have been impregnated last year. Special cisterns or service boxes are being put to every water-closet where they were before wanting, so that no closet will henceforth be supplied from any drinking water pipe, and therefore there cannot henceforth be any suction from any closet into any such pipe. After a very minute examination of the college, no other precaution suggests itself to me as being required.

In conclusion I must express my grateful sense of the assistance which I had from every one whose help I had occasion to apply in Cambridge. But very particularly I must record my thanks to the Rev. John Lamb, bursar of Caius College, for his incessant and laborious co-operation, to which this Report owes the greater part of what it may contain of value ; to the Rev. N. M. Ferrers for his valued mathematical assistance; and to Drs. Paget and Bradbury for their important counsel and kindly criticism.

NOTE.

The following regulations indicating the right method of supplying water to waterclosets in a place where the so-called "constant service" plan of water delivery is in use, are extracted from the "Regulations under the Metropolis Water Act, 1871." These regulations, having for their object the "preventing of undue consumption or contamination of water," are the result of an inquiry made for the Board of Trade by Lord Methuen, Captain Tyler, and Mr. Rawlinson, C.B. They have the sanction of the Board of Trade, and may be put in force by the London Water Companies :—

"20. *Every* boiler, urinal, and *watercloset*, in which water supplied by the company is used (other than waterclosets in which hand flushing is employed), *shall*, within three months after these regulations come into operation, *be served only through a cistern or service box*, and without a stool-cock, *and there shall be no direct communication from the pipes of the company to any* boiler, urinal, or *watercloset*."

"24. *No pipe by which water is supplied by the company to any watercloset shall communicate with any part of such watercloset, or with any apparatus connected therewith, except the service cistern thereof.*"

No. 4.

Report by Dr. Ballard upon an Outbreak of Enteric Fever at Armley, in the Borough of Leeds.

In the early part of the month of August information was received by the Local Government Board of an outbreak of enteric fever having occurred at Armley, a suburb of the town of Leeds, accompanied by an intimation that public rumour attributed it to the use of one particular milk supply; and I was instructed to proceed at once to its investigation. On my arrival in Leeds, I sought an interview with Dr. M. K. Robinson, the Medical Officer of Health of the borough, within which the township of Armley is situated. I found that Dr. Robinson was quite aware of the fact of the outbreak, and that he had already commenced an inquiry into the cause of the fever. The inquiry instituted by him, however, was not so far advanced as to render mine unnecessary, and he immediately placed all the information in his possession at my disposal. During the whole time that my investigation lasted, Dr. Robinson and the officers under him gave me their personal assistance, and I am bound to express here my sense of the high value which attached to that assistance. It was impossible for me within the limited time that I could give to the investigation to gather together all the data requisite for an indisputable inference, and after I had left the town Dr. Robinson undertook and ably carried out the collection of such additional facts as appeared to be necessary.

The township of Armley is situated at the extreme west of the town of Leeds; it lies upon the south side of the River Aire, and chiefly upon the northern slope of a hill with a tolerably steep descent to the river.

Originally a suburban village of little importance, it has of late years been greatly extended by the erection of new houses in streets and blocks chiefly towards and at the summit of the hill and on its southern slope. There are some few villa residences in the outskirts, but the greater number of the newer houses are, like the majority of those in the older part of the village, of the cottage class.

Immediately beneath the surface-mould the soil, to a great depth, consists of a rocky shale which is loose in structure and readily permits the permeation of water.

The drainage throughout the township is very defective. No sewers have been provided anywhere except in some of the new roads now in course of construction. In the older part of the village of Armley there are some square drains, very imperfectly constructed of small slabs of stone. They are scarcely adapted even for carrying off the surface water from the roads, but are used, nevertheless, for the reception also, by means of open and untrapped gratings, of the domestic sewage of the village. When I was in the village the emanations from some of these drain gullies were intolerably offensive. In some of the newer parts of Armley pipe drains have been laid in, but even in some of these newer parts the drains are constructed as they are in the older parts, and the inlets are simply untrapped "dish-stones" which are commonly placed just outside the doors of the houses. Drain inlets within houses also, such as those at sink stones, are not by any means invariably trapped. In many parts the cellars are wet, and in times of heavy rain, in consequence of the small calibre and choking of drains, they become flooded.

Very few houses, even of the better class, are provided with water-closets. Large privy cesspools are the rule throughout the place; no

public arrangements are made for their cleansing, and everywhere they were found exceedingly offensive. Taking into consideration the nature of the soil into which these cesspools are dug, and the loose construction of the drains in the village, the earth upon which the dwellings stand must be greatly polluted with soakage from both.

The water supply of Armley is from the Bramley reservoir of the waterworks of the corporation of Leeds, and is given by pipe and tap to the houses individually. I heard no complaint of the quantity furnished, but in some parts complaints were made by householders that the water had a fishy taste and odour in the hot weather. But these complaints were by no means universal. The analysis, by Dr. Dupré, of a sample of the water, which I took directly from the Bramley reservoir, gave satisfactory results. The details of his analysis are given in the Appendix to this Report.

Dr. Robinson tells me that Armley is one of those parts of the borough which is scarcely ever absolutely free from enteric fever, cases of which, although most abundant in the older and more low-lying parts of the village, have nevertheless occurred frequently in the newer parts also. It is his practice to inquire into the circumstances under which every fatal case of this disease has occurred, and he attributes the endemic persistence of enteric fever in Armley to the absence of proper drainage and to the excrement nuisances which abound there, and apparently with good reason. I have rarely seen anything better calculated to promote the spread of enteric fever than some of the privy arrangements in this place.

Still, taking as indices the Death Register and the Medical Relief Book of the Union Medical Officer, with such lists of cases of the disease as I could obtain from private medical practitioners, there does not appear to have occurred in Armley any great number of cases of enteric fever during the present year before the month of July; and then an outbreak occurred there unprecedented in extent in the experience of resident practitioners, and of the Medical Officer of Health. It was this outbreak which it became my duty to investigate.

Up to the end of April this year only two deaths from enteric fever had occurred in Armley, and by inquiry among the medical men practising in the township, I can only ascertain two other cases, which happened in April. It is probable, however, that there were others, but they were not so numerous as to attract any particular attention. On the 17th May two cases came under the observation of Mr. Coleman. One of them was that of a dairyman in Hall Lane, Armley, who, after consulting Mr. Coleman for some days at his surgery, and having kept at work as long as he could, first took to bed on that day. There is reason to believe that this man got his fever at a neighbouring town.* The other case was that of a man aged 22, residing in a house at Cricket Field, on the southern slope of the hill. It was fatal on May 24. Four or five weeks now elapsed before another case was observed, and then a man, aged 37, who worked at some ale vaults in Leeds, but resided in one of a block of four back-to-back houses, known as Oakes' houses, not far from the dairyman's dwelling, was attacked with enteric fever. He first came under observation on June 20, and he died from the fever on July 29. Before he died some of his family had been similarly attacked, the first of them about July 20, and after his death other cases happened among the children—the last case on August 27. Altogether five cases of enteric fever occurred in this house. From June 20 ten

* He had been in company with another person, who, it is believed, was taken ill with a similar fever about the same time.

days now passed without the known occurrence of any fresh case, and then came a sudden outburst. During the week which commenced on Sunday, June 30, and ended on July 6, cases of enteric fever came under observation in no fewer than 12 houses in Armley; in the next week, ending July 13, eleven fresh houses were invaded by it; in the next week, ending July 20, ten more houses, and in the week ending July 27, sixteen more. In the following week the number of fresh invasions suddenly fell to two; and from the first week in August until the end of the first week in September, a period of five weeks, there were altogether only fourteen fresh houses invaded by the fever. The total number of houses invaded during the above-mentioned seventeen weeks was sixty-eight; the total number of cases of fever which I have been able to ascertain was 107, of which eleven were fatal. These 107 cases were not scattered equally over all parts of the township, but were located within a limited space, which there was no difficulty in defining upon a map, and which is defined upon the plan which accompanies the office copy of this Report. The line defining the infected part of Armley includes a portion of the older, lower, and more crowded part of Armley, but chiefly that part in which the houses are comparatively new, and are built in airy situations upon the rise of the hill and upon its summit. Nor were the invasions of the fever confined to the cottages of the labouring class of the population; for although the greater number of the cases were met with in such cottages (as might have been expected considering their numerical preponderance), yet the fever did not spare the occupants of some of the least crowded together of the residences in Armley. The vicar of the parish had a severe attack, and one or more members of several families sufficiently well off to keep domestic servants also suffered.

The following Table has been constructed to show the progress and subsidence of the epidemic week by week, and, during the four weeks of its principal prevalence, the number of cases coming under observation, and of fresh houses invaded, day by day :—

		Daily.		New Cases coming under Observation each week.	Houses newly invaded each week.
		New Cases coming under Observation.	Houses newly invaded.		
1872. Week ending—					
May 18				2 (1 fatal)	2
„ 25				—	—
June 1				—	—
„ 8				—	—
„ 15				—	—
„ 22				1 (fatal)	1
„ 29				1	—
July 6	June 30	1	1	14 (3 fatal)	12
	July 1	4	4		
	„ 3	1	1		
	„ 4	3	2		
	„ 5	1	1		
	„ 6	4	3		

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		Daily.		New Cases coming under Observation. each week.	Houses newly invaded each week.
		New Cases coming under Observation.	Houses newly invaded.		
July 13	July 7	6	4	22 (2 fatal)	11
	„ 8	1	1		
	„ 9	3	—		
	„ 10	3	1		
	„ 11	3	2		
	„ 12	3	1		
	„ 13	3	2		
July 20	„ 14	2	—	19 (2 fatal)	10
	„ 15	7	4		
	„ 17	5	4		
	„ 18	1	—		
	„ 19	1	1		
	„ 20	3	1		
July 27	„ 21	3	2	24 (2 fatal)	16
	„ 22	4	1		
	„ 24	3	3		
	„ 25	6	4		
	„ 26	3	3		
	„ 27	5	3		
Aug. 3				5	2
„ 10				5	5
„ 17				2	2
„ 24				4	3
„ 31					1
Sept. 7				1	1
Invasions and attacks, the dates of which are not ascertained				5	2
Total				107	68

Thus the epidemic commenced suddenly, and almost as suddenly abated. Another remarkable feature in it was that, out of the twelve houses invaded in the first week of the epidemic, ending July 6, there were only two in which a solitary case occurred. In each of the remaining ten houses from two to six cases happened in succession. Again, in the second week of the epidemic, out of eleven houses newly invaded there were but three in which solitary cases of the disease were observed. From the third week of the epidemic onwards, however, the very reverse of this was noticed. Out of ten houses newly invaded in the third week, multiple cases in a house were only observed in two, while, in the fourth week, solitary cases only occurred in each of the sixteen invaded. All subsequent new invasions of houses were represented by solitary cases of fever, except in two instances. Whatever the explanation of the cause of the epidemic may be, the true cause can only be one which shall suffice to account satisfactorily for the facts just mentioned, viz., the suddenness of the outburst, the suddenness of the arrest of the epidemic, and the fact that multiple cases in a house were almost entirely confined to houses invaded during the first fortnight.

Of the 107 cases, 55 were males, 52 were females.

The attacks were met with in persons of all ages up to 65 years, and were distributed as shown in the following Table of 53 males and 52 females, whose ages are known :—

—	Males.			Females.			Both Sexes.		
	Under 5 Years.	5-14 Years.	15 Years and upwards.	Under 5 Years.	5-14 Years.	15 Years and upwards.	Under 5 Years.	5-14 Years.	15 Years and upwards.
Week ending—									
May 18th	—	—	2	—	—	—	—	—	2
June 22nd	—	—	1	—	—	—	—	—	1
„ 29th	—	1	—	—	—	—	—	1	—
July 6th	—	1	5	1	2	5	1	3	10
„ 13th	1	3	8	1	1	8	2	4	16
„ 20th	2	3	4	—	3	7	2	6	11
„ 27th	1	7	4	1	5		2	12	10
Subsequently	—	4	4	3	4	3	3	8	7
Date of attack unknown.	—	1	1	—	1	1	—	2	2
	4	20	29	6	16	30	10	36	59

In the above Table the comparatively late period in the epidemic at which most of the children were attacked is worthy of observation. Whatever the cause of the outbreak may have been, the older persons, on the whole, were attacked earlier than the younger, who either resisted more strongly the operation of the cause, or exhibited a longer period of incubation. This fact also comes out on comparing the mean ages of those attacked week by week. Thus:—

The mean age of	14	persons attacked	in the week ending	July 6,	was	$21\frac{1}{14}$ years.
„	22	„	„	July 13,	„	$20\frac{14}{22}$ „
„	18	„	„	July 20,	„	$18\frac{17}{18}$ „
„	23	„	„	July 27,	„	$15\frac{19}{23}$ „
„	18	„	in subsequent weeks		„	$14\frac{15}{18}$ „

Of the medical men practising in Armley, only one, namely, Mr. Coleman, the Union Medical Officer of the district, formed any decided opinion as to the origin and cause of the spread of the fever. It has been mentioned above that one of the two cases of enteric fever, which he was called upon to treat in the month of May, occurred in the person of a dairyman; and he observed that all the families attacked with the fever at the commencement of the outbreak dealt with this dairyman for milk. Naturally enough, the coincidence struck him as remarkable, and he mentioned it to Dr. Allbutt, of Leeds, who then brought to his notice for the first time the observations which I had made during a similar outbreak in Islington in the summer of 1870. At the date of the commencement of the present inquiry, Mr. Coleman alone held the opinion strongly that the fever had been spread by the milk proceeding from the infected premises of the dairyman. Dr. Robinson, although quite aware of the possibility of Mr. Coleman's surmise being correct, was little disposed to accept it, mainly on the ground that other explanations more probable had not been excluded, but, secondarily, on the ground of his experience of enteric fever on former occasions, both in Armley and in other parts of the borough. He was much more inclined to attribute the origin of the fever to the wretched condition of the drainage of the place, and its spread to personal communication with infected houses and persons, and to the use of privies infected with the dejections of the sick. During the heavy rainfall that preceded the outbreak, sewer air had been forced back into the houses, and sewage had bubbled up, he says, through the gully openings, and had penetrated into houses, and flooded cellars and yards in many parts of Armley: these conditions appeared to him to have been instrumental in promoting the outbreak. Before the inquiry was completed, however, some very curious facts.

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which had been established served to modify his views upon the subject.

On obtaining a full list of the cases of fever that had occurred, and on arranging the invasions of the several families attacked in chronological order, the *primâ facie* case presented to me by Mr. Coleman was considerably strengthened. Every family attacked up to the end of the first week in July dealt with the dairyman who had been sick with the fever in May ; so did every family, with the exception of one, invaded in the second week of July ; so did every family invaded in the third week of July. After this there was less uniformity in the milk supply of the houses invaded. In the fourth week of July, out of sixteen families newly invaded, ten dealt with this dairyman, while the remaining six distributed their custom among other milk sellers. The remaining sixteen families invaded subsequently, or at dates not precisely ascertained (but certainly late in the epidemic), dealt for milk as follows ; viz., seven with the dairyman in question, seven with three other milk sellers, while in respect of the two, the source of the milk supply was not discoverable.

Whether the spread of the fever was due to the use of milk from the suspected dairyman's premises or not, it was thus at least clear that the part of Armley in which his business was principally carried on coincided to some considerable extent with the locality of the fever, as defined by the line drawn upon the plan accompanying the office copy of this report. But, inasmuch as it was not known to what extent the dairyman in question supplied the houses within the district, it became necessary to institute a house-to-house inquiry. This was partly carried out by myself, and partly by Dr. Robinson and his Superintendent Inspector of Nuisances.

The number of dwellings within the boundary line above mentioned was found to be 449, and they were occupied, with few exceptions, by separate families. Assuming that on an average there were five persons in each house, the population of the district would be about 2,245. It appears then that about 15 per cent. of the houses were invaded by the fever, and nearly 4·8 per cent. of the population were attacked by it. Of the 68 houses invaded, 51, including that of the milk seller himself, were supplied with milk by the dairyman in question ; 13 were supplied by various other milk sellers whose names were known ; one had no milk from anybody, and the source of milk supply to three was doubtful or unknown. It might have turned out after all that the proportion of invaded houses supplied by the suspected dairyman was no greater than the proportion of all the houses which he supplied with milk in the district. But inquiry showed that, although he actually supplied a very large number of houses within the defined district, he did not supply anything like 51-68ths of them. As a list of customers could not be obtained from the dairyman, it became necessary to ascertain the milk supply during the epidemic period by special inquiry at each house. The result of the inquiry was that, of the 449 houses within the defined district, 132 were supplied by the dairyman who had been ill, and the 317 remaining houses are accounted for as follows, viz., 37 never took in any milk at all ; in respect of three the milk supply was doubtful ; and 277 families occupying the remaining houses distributed their custom among 18 different milk sellers, of whom one supplied 80 families ; one, 49 ; one, 45 ; two, 37 families each ; one, 25 ; and one, 11 families.

We have arrived therefore at this, that altogether 37·8 per cent. of the families this single dairyman supplied with milk, after he himself had been attacked with enteric fever, were invaded by the same disease, while only about 5·3 per cent. of the families supplied by 18 other

milk sellers, or not taking milk at all, suffered from the fever. Of course the question must arise how was it, if the milk supply from the one infected source was the cause of the outbreak and of its spread, that 17 families not thus supplied suffered at all? And this question must be answered. The key to its solution lies in the observation that nearly all these 17 invasions occurred in the fourth week of the outbreak, and in subsequent weeks. During the first three weeks of July only one family not supplied from the infected dairy was attacked. Hence it is probable that the other 16 family invasions were instances of extension of the fever through the medium of privies, sewers, drains, &c., in places where the specific discharges of some of the earlier cases had been deposited. It was scarcely to have been expected that, even on the cause which occasioned the earlier cases ceasing to operate, the fever would fail to spread for a time in a place so imperfectly drained and cleansed from excrement, and with a soil so permeable as that of Armley. And in most of the 17 instances referred to, if not in all of them, exposure to the operation of virus conveyed by one of these media could be traced.

But while some of the later invasions and attacks of fever may be accounted for in this manner, it was impossible thus to account for the earlier cases, inasmuch as, up to the period of my visit to Armley in the middle of August, the evidence of any earlier spread of the disease in this manner was very slight. I have in my notes a record of many groups and blocks of houses which I made the subject of special personal investigation, taking them hap-hazard, each group or block using one common privy. In all of them, those families only had been invaded who obtained milk from the suspected source; the disease having up to that time been limited to such families, and having spared those who obtained milk from a different source, although using the same privy with the families invaded. Still, as I have said, at a later period in the outbreak there was more distinct evidence that the disease had begun to spread through the medium of infected drains, privies, and soil.

The manner in which the fever picked out the customers of the dairyman in various rows and blocks of houses, sparing other families, was indeed remarkable. Beside the instances referred to in the last paragraph many others might be adduced. Two may suffice in illustration. In Hall Lane, close to the dairy, is a row of 10 houses occupied by well-to-do families. Eight of these families obtained milk from the dairyman in question, and of these five were invaded by the fever. The other two families obtained milk from other sources, and neither of these families suffered. The other instance is the most remarkable of all. There is near Armley Gaol, and at a distance of half a mile from the dairyman's premises, a row of 12 new houses (Hawthorn Place), in one of which a lady aged 53, who very rarely left the house, died from the fever, with which she was attacked early in July. Inquiry was made by Dr. Robinson from house to house, and it was ascertained that no one else in the row had similarly suffered. It was also ascertained that this family alone dealt regularly with the dairyman in question, and as it was beyond the district he supplied, a son of the lady who died fetched a quart of milk every afternoon, of which she took a considerable portion every night for her supper. There was one other house in the row where the milk from this source is said to have been occasionally taken in, but no fever occurred in it.

In the course of the investigation I took some trouble to discover the quantity of milk consumed by the individuals attacked, and in a considerable proportion of cases I obtained the information sought. Thus I have notes of 19 cases in which it was especially mentioned that

the suspected dairyman's milk was very freely used as an article of diet, commonly at supper, either cold or boiled. All but four of these individuals applied for medical aid in the course of the first fortnight of the outbreak. On the other hand, I have notes of 24 cases in which it is especially mentioned that the individuals took very little milk, and of these 17 sought for medical aid in the course of the third and fourth weeks of the outbreak, and only three in the first and five in the second week. So that it appears that the largest consumers of the suspected milk were among the earliest, and the smallest consumers among the latest attacked.

It may now be considered established that the outbreak of enteric fever which suddenly occurred in the first week of July in Armley was caused by the distribution through a part of the township of milk from a particular dairy where the dairyman himself was lying ill with enteric fever, and where subsequently two of his children also suffered from the same disease.

As to the mechanism of the distribution of the fever from the dairyman's premises, there arises at the outset a question which it is desirable to answer, but to which, in the nature of things, a direct answer can hardly be expected. Was it water added to the milk that produced the enteric fever among families supplied from the dairy? No one knows anything of enteric fever being propagated by cow's milk, *per se*, while there is very ample knowledge about the spread of such fever by means of water. The following considerations lead one to believe that it really was not through milk, but through water added to milk, that the customers of the Hall Lane dairy got their infection of enteric fever. Houses occupied by families supplied from this dairy were invaded freshly, one after another, almost every day up to July 27th: on that day three houses so occupied came freshly under medical notice; and from that day the epidemic, as such, was at an end. In the whole of the next week only one family dealing with the Hall Lane dairy, applied newly for medical aid.* This sudden cessation of the fever epidemic among this section of the community on July 27th, means that the cause of the epidemic had ceased for them a fortnight or more previously, since in enteric fever there are commonly 11 days of incubation and several other days before medical advice for its symptoms is sought. July 10th would therefore be about the time when the cause of the epidemic among customers of the dairy suddenly ceased to operate. Now, on July 10th, Dr. Robinson had the handle of the pump at the Hall Lane Dairy chained up, and thenceforth it was kept chained. There was coincidence therefore between the cessation of the fever and the cessation of the opportunity that the dairy had to supply a particular water; while there was no suggestion that the cows or their milk had undergone any change.

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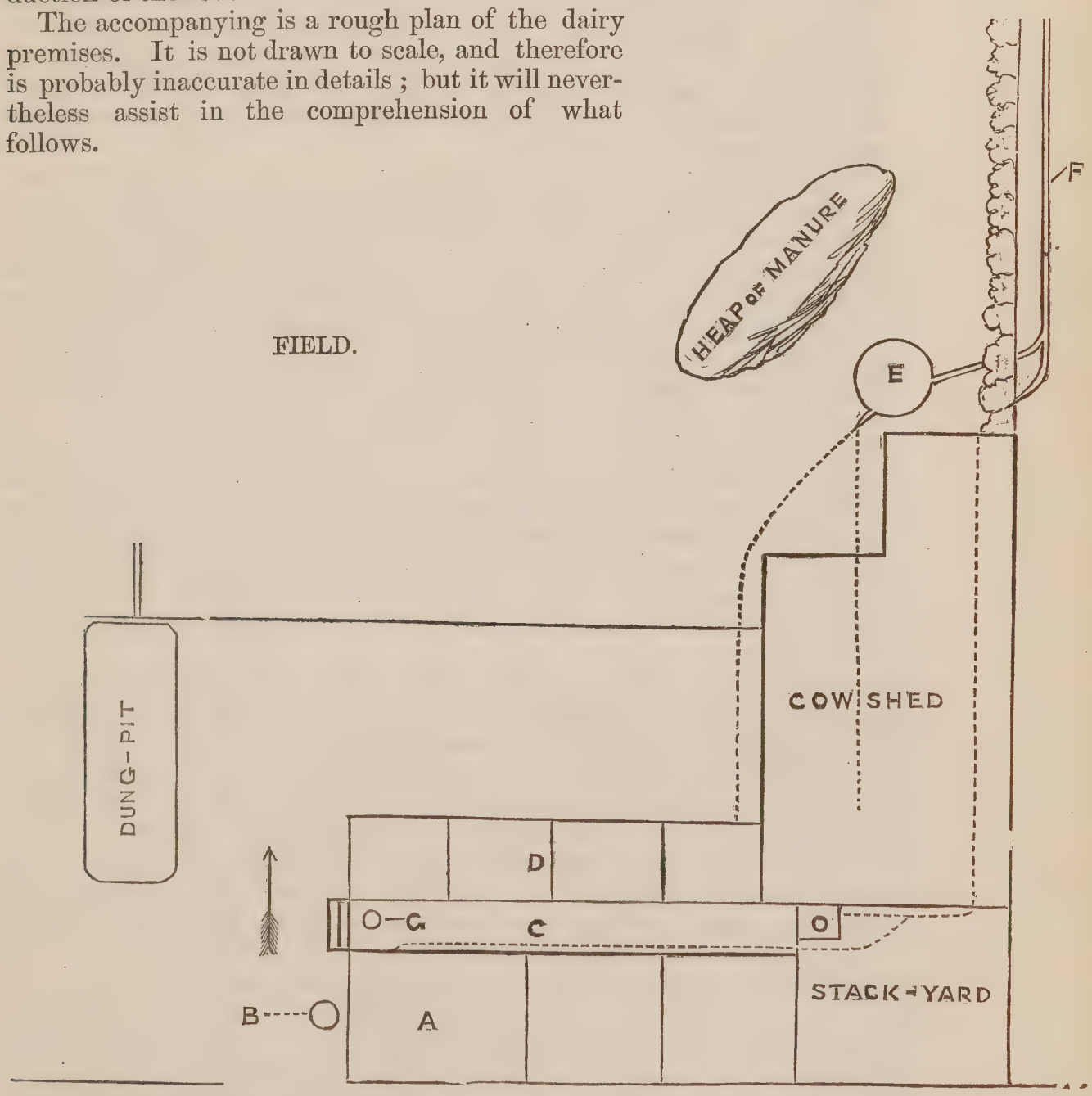
* In the week ending August 3, only one family was invaded. The attack occurred in the person of a little girl, for whom medical aid was sought on July 28. We know how obscurely this fever may begin in a child, and the mother of this girl, from what I learnt about her, was quite the sort of person to pooh-pooh the child's illness until it became really serious, so that it may well be believed that she was ill long before the 28th. The next case came first under observation on August 4, and it occurred in the person of a young man who resided in the lowest house of a row of cottages, in several of which fever had occurred, and the common drain from which passed his house where there was an untrapped opening opposite the door. He is very likely to have received the virus from this source, and not from the milk he used. Between this date and September 1, altogether 11 houses were invaded by fever, but out of all of them only four were occupied by families using the milk from the dairy in question—a proportion no larger than might be not unfairly accounted for by the proportion of families in the district supplied from it with milk.

It is, as I have said, not to be expected that evidence, other than circumstantial evidence, should be obtainable respecting the admixture of water with the milk. If it occurred as an adulteration (such as dairymen are pretty generally accused of practising) the fact would be concealed; if accidentally, the fact would have escaped notice altogether, or would be forgotten.

No direct evidence on the point was forthcoming beyond certain admissions about the use of water from the well of the premises in cleaning out the milk cans. I propose, therefore, to give the evidence that could be obtained, relating to the position and construction of the well, the character of its contents as observed by myself and as determined by analysis, the opportunity that the well had to become specifically infected, and the coincidence in point of time between such infection and the cause of the fever among the milkman's customers. This evidence, joined with the facts above given as to the cessation of the epidemic when the well-water was disused, will leave, I think, no doubt about the part that was played by the dairyman's well in the production of the fever.

The accompanying is a rough plan of the dairy premises. It is not drawn to scale, and therefore is probably inaccurate in details; but it will nevertheless assist in the comprehension of what follows.



A. Dairyman's house.
B. Well, with pump.
C. Paved way to back doors of houses.
D. Row of pigsties.
E. Open cesspool.
F. Open drain.
G. Urine tub.
- -- Course of drains.

The dairyman's house is the first in a row of three cottages which have doors opening in front upon the lane, and at the rear upon a paved passage which is artificially raised to the level of the roadway in front, and is reached by one or two steps. The land slopes so much downwards, in the direction of the arrow, at the rear, that the roofs of the row of pigsties marked D on the plan are at the level of the paved way. In most other respects the plan explains itself. The dung-pit is situated about five yards from the well. It is very large, and dug about three feet into the earth and rocky shale. At the time of my visit it was full of filth and manure, and was partly drained by a channel cut in the earth into a field in the rear. The paved way at the rear of the cottages is provided with a covered channel for slops, but the pipe intended to convey the slops through the wall at the end of the passage to the drain in the stack yard at a lower level was, at the time of my visit, choked up. The privy for the three cottages at the end of the paved way was full of excrement, from which some liquid matter alone drained imperfectly away by means of a pipe drain at the rear. There was an oozing of liquid matter also on to the surface of the stack yard behind the privy. Altogether the drainage arrangements were found to be exceedingly bad. The cesspool E receives the drainage from the cow shed, pigsties, and privy, and all the household slops, except the urine, which is collected in a sunken tub at the entrance to the paved way, and only a few yards from the well.

The well was situated at the side of the dairyman's cottage, and was covered with a slab of stone. On removing the cover I found that the well was sunk in the porous shale of the district to a depth altogether of 36 feet; the depth of water was 12 feet, and the distance from the surface of the water to the top of the well was 24 feet. From the top of the well to a depth of 22 feet the sides were formed of bricks loosely laid upon one another without cement. Below this depth the surface of the shale was exposed. For the first four feet from the top of the well the outside of the brickwork was puddled with clay, but not lower. All the way down below the place where the puddling ceased there was observed an oozing of black matter from between the bricks, and below the spot where the brickwork ceased the oozing was considerable, as shown by the staining of the stony portions of the soil, and by a black stain 12 inches wide on the side next the dung-pit reaching to the water two feet lower down. There was a deposit of mud and filth at the bottom of the well which gave off abundant bubbles of gas on being disturbed.

Previous to exploring the dairyman's well a sample of the water was taken for analysis. The details of the analysis are given in the Appendix to this Report. Briefly, I may state here that it gave evidence of considerable sewage contamination, and that although nearly all the organic matter in the specimen collected on August 22nd had become oxidised, the water contained much chlorine and an excessive amount of nitric acid which could only have arrived at it in the manner mentioned. The water then was polluted with sewage matters, evidently in great measure from the dung-pit, but partly also almost inevitably by soakage through the soil from the privy or from defective drains and perhaps also from the decaying urine-tub which had evidently been many years in use.

That the water had thus an excellent opportunity of being polluted with human excrement can scarcely be disputed. Even supposing that no slops containing such excrement had been at any time thrown into the dung-pit, an event which the slovenly habits of the family render by no means improbable, there were other chances for these slops or the soakage from the privy getting into the water.

I propose next to show that the well probably became from a parti-

cular time specifically polluted with the matter of enteric fever, and this was exactly the time at which the cause of fever among the milkman's customers began to operate.* Among these people the earliest cases came under observation about the 1st of July. Probably these persons, as well as most of the individuals on my list who were attacked, had been ill for a period of a few days to a week before they sent for their medical attendant; and then to this interval must be added 10 or 11 days as the period of incubation before we can fix upon a date on which the persons earliest attacked received the virus into their stomachs. This date then will be thrown back to a time somewhere between the 14th and the 21st June. Mr. Miall, of the Philosophical Hall at Leeds, has kindly furnished me, through Dr. Robinson, with a copy of his rainfall register, week by week, prior to and during the outbreak. And I find from this that the weekly rainfall during the months of May, June, and July was as follows :—

Week ending—	Rainfall in inches.	Week ending—	Rainfall in inches.
May 4	0·539	June 22	1·065
„ 11	0·410	„ 29	1·556
„ 18	0·811	July 6	0·240
„ 25	—	„ 13	3·190
June 1	0·036	„ 20	1·170
„ 8	1·400	„ 27	0·800
„ 15	0·539		

The dairyman was taken ill in May. During the whole of May the rainfall was moderate, and no rain at all fell in the first week after he took to his bed. In the second week very little fell, but in the third week nearly an inch and a half fell, and in the fourth week more than half an inch more. It was at this time then that, in all probability, the virus began to be washed from the dung-pit or polluted soil towards the well, and it might take a few days more for it to arrive at the water. That the process of percolation was ordinarily a slow one appears to be shown by the oxidised condition in which the organic matters mostly reached it. But we must believe, taking the period of this rainfall into consideration, that foul matters, at the time having specific infectious qualities, were being passed into the well with particular rapidity during the second week of June, that is to say, just before the time that the earliest cases may be presumed to have received the virus. In the two following weeks a great deal of rain fell, which would naturally continue to wash the virus out of the soil into the water.

I stated in an earlier part of this Report that, whatever the true explanation may be, it should be such as should account for the suddenness of the commencement and of the cessation of the epidemic outbreak, and that it should also be capable of accounting for the fact that multiple cases were almost entirely confined to houses invaded early in the epidemic. The first requirement has been fulfilled; and I submit that the explanation given above also fulfils the second: for had it been true that the second, third, or subsequent attack in each family had been due to any other cause than the same cause as produced the first case in the family, viz., the use of the same polluted milk; if they had

* This well was in ordinary use in the dairyman's house and in two adjoining cottages. Members of the dairyman's family, and the nurse who attended on him, were attacked with the fever after his own illness. In one of the adjoining cottages there were, about the same time, two cases of fever. At this time the second cottage escaped, the only people who took their meals there being two old persons probably insusceptible of the disease. About a month, however, after the pump was chained, a girl who slept at this second cottage became ill of fever, having probably got it elsewhere.

been due, for instance, to accidental causes connected with the pre-existence of a first case in the house ; we should naturally have expected that, in due time, the families invaded by the epidemic at the later period would have presented multiple attacks in the same way as those attacked earlier. But such was not the case.

It is not necessary that I should point the moral of this history, or deduce from it the warning that it must convey to any thoughtful mind. The Adulteration of Food Act of last Session enables local authorities to deal with persons who add water to milk ; but if a dairyman's own drinking water is permitted by local authorities to be a fluid little better than sewage, is it not rather a reflection on those authorities than an aggravation of his commercial fraud, that he, only meaning to dilute his milk, ignorantly supplies infection to his customers ?

But I must say something, before I conclude, about the local authority in Armley, which is the Corporation of the borough of Leeds. The unwholesome condition of the outlying township of Armley should early receive the serious consideration of the Leeds Corporation, especially in respect of sewerage and house drainage, and the frequent removal and safe disposal of excrement. It is not necessary for me to dwell in detail upon either of these subjects, inasmuch as they were fully brought under the notice of the Corporation as long ago as July 1871, by Mr. J. N. Radcliffe, in his report on the sanitary state of Leeds. A year and a half has elapsed since that report was presented, and nothing has been as yet done to carry his recommendation into effect in this suburb ; notwithstanding that it is one of those parts of the borough which the Medical Officer of Health of the Corporation has mentioned in his report for 1871, as among the localities in which fever principally prevailed during that year, and which he mentioned to me as one from which enteric fever is rarely absent.

Note.

The following is the result of the chemical analysis made by Dr. Dupré of the two samples of water mentioned in this Report, both taken August 22, 1872 :—

1.—*The Water of the Bramley Reservoir.*

The water is almost perfectly clear, leaving only a minute trace of deposit ; it is soft, becomes extremely soft by boiling, and contains only traces of nitric acid and chlorine. But little organic nitrogen and only minute traces of ammonia are present ; the water is in these respects extremely pure. It contains, however, an appreciable amount of some vegetable (peaty) matter, which gives it a decided colour, and absorbs a comparatively large amount of oxygen. Moreover the dry residue when ignited shows much blackening.

The following are the details of the analysis :—

Appearance - - -	Clear.
Colour - - - -	Pale brown yellow.
Deposit - - - -	Fine granular.
Taste - - - -	Slightly mouldy.
Smell - - - -	Ditto.
Nitrous acid - - -	None.
Phosphoric acid - - -	Extremely minute trace.
Hardness, on Clark's scale - -	9·5 deg.
,, after boiling - -	3·5 deg.

	Grains per gallon.
Oxygen absorbed from permanganate	0·101
Total solids	9·240
Consisting of—	
Volatile matters	3·199
Fixed salts	6·041
Chlorine	0·490
Nitric acid (N_2O_5)	0·205
Nitrogen in ammonia	0·0017
Organic nitrogen	0·0105

2.—*The Water from the Well on the Premises of the Dairyman referred to in the Report.*

The water is turbid and extremely hard, even after boiling. It contains much chlorine and an excessive amount of nitric acid, both probably derived from some considerable sewage contamination. Although, at present, nearly all organic matter has become oxidised, the water is nevertheless a very bad one.

The analytical details are given in the following table :—

Appearance	Somewhat turbid.
Colour	Yellowish.
Deposit	Brown, flocculent.
Taste	Very slightly mouldy.
Smell	Inodorous.
Nitrous acid	Minute trace.
Phosphoric acid	Trace.
Hardness, on Clark's scale	54 deg.
„ after boiling	52·5 deg.

	Grains per gallon.
Oxygen absorbed from permanganate	0·042
Total solids	102·060
Consisting of—	
Volatile matters	19·890
Fixed salts	82·170
Chlorine	9·600
Nitric acid (N_2O_5)	15·422
Nitrogen in ammonia	0·0042
Organic nitrogen	0·0084

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Enteric Fever at Moseley and Balsall Heath, by Dr. Ballard.

Report by Dr. Ballard, upon an Outbreak of Enteric Fever at Moseley and Balsall Heath, near Birmingham.

On January 2nd I received instructions to inquire into a serious outbreak of enteric fever which had suddenly occurred at Moseley and Balsall Heath, suburbs of Birmingham. These places are situated on the summit and sides of a ridge of hills running in a southerly direction from Birmingham. The causes to which the fever had been popularly attributed were the absence of proper drainage and the pollution of the wells with sewage matters.

I found on inquiring that the porous soil on which these places are situated had, in fact, become extensively polluted by soakage into it from dumb wells or of matters from time to time pumped out of them, as also by soakage from badly constructed drains and ash-pit privies, and that there was abundant evidence that the wells which had supplied water for domestic use to the greater part of the population were also much polluted with sewage or excremental matters. But I found also that these conditions, prevailing widely throughout Moseley and Balsall Heath, failed to explain the peculiar distribution of the fever, or to account for the invasion of certain families, while neighbouring families in apparently similar circumstances had entirely escaped. Moreover I ascertained as fact, and was unable merely by reference to existent local conditions to explain how it had arisen, the fever had spared the whole class of the population which when ill is in the habit of seeking parochial medical relief, while it had attacked families residing in the best villa residences in Moseley, and many families residing in expensive houses in which the local conditions usually regarded as promotive of enteric fever were less obviously present than among the poorer classes.

The private medical practitioners who were in attendance upon cases of fever kindly gave me their assistance in the inquiry which I instituted, and permitted me to see all the persons who were suffering at the time of my visit, and in all I recognised the fever as enteric. Some of the cases were very severe and very typical, but others, as is usual in similar outbreaks, were milder and less strongly marked. All, however, that I saw were sufficiently characterised to enable me to determine the nature of the disease.

Prior to the end of November there had been no unusual prevalence of enteric fever in Moseley and Balsall Heath, but in the course of the last few days of November and the first week of December (ending December 7) 20 families in these districts were invaded; in the week ending December 14th, 11 families; in the week ending December 21st, 12 more families; and in each of the two succeeding weeks, three families. One family was attacked, the precise period of invasion of which is not known. Thus 50 families (23 in Moseley and 27 in Balsall Heath) are known to have been invaded by enteric fever between about the 24th November and the 6th January. In these families 96 cases (51 in Moseley and 45 in Balsall Heath) occurred, of which 10 were fatal.

The following table shows the number of families invaded and the cases occurring week by week during this period.

Successive Weeks of the Epidemic.	No. of Families invaded.	No of Fresh Cases.	Died.
Week ending November 30 - -	4	5	1
„ December 7 - -	16	25	3
„ „ 14 - -	11	22	4
„ „ 21 - -	12	17	1
„ „ 28 - -	3	14	1
„ January 4 - -	2	5	—
„ „ 11 - -	1	5	—
Date unknown - - -	1	3	—
Total - - - -	50	96	10

I have not been able to ascertain the invasion of any new families subsequently to January 11th. The number of cases in a family varied from one to seven, the largest number of attacks occurring in those families which were invaded the earliest, as shown in the following table :—

Cases as distributed among families attacked in successive weeks.

Weeks in which Families were attacked.	Total.		Families with Cases respectively as below.				
	Cases.	Families.	One Case.	Two Cases.	Three Cases.	Four Cases.	Five Cases and upwards.
1st week - - -	49	20	7	6	2	3	2
2nd week - - -	18	11	6	3	2	—	—
3rd week - - -	17	12	9	1	2	—	—
Later - - -	10	6	4	—	2	—	—

Of the 91 whose ages are known, there were 25 under five years of age, 36 between five and 14 years of age, and 30 at ages varying between 15 and 52 years. Of those over 15 years, 24 were females. Hence out of the whole number attacked (whose ages are known) it is noticeable that only six were males above 15 years of age (of whom only three were aged 20 and upwards) while all the rest of the sufferers were women and children.

Failing to find an explanation of the peculiarities of this outbreak in any peculiarities of local conditions under which the invaded families lived, other than those under which other families lived which were not invaded, and guided by the former experience of similar outbreaks, I turned my attention to the milk supply of the neighbourhood, and the result of my inquiries in this direction was as follows :—

Of the 50 families invaded, 31 obtained their supply of milk from a milk-seller in Balsall Heath, whom I will call No. 1 ; four obtained their milk from a milk-seller whose premises adjoin those of No. 1, one house only intervening, whom I will call No. 2 ; 10 obtained their milk from a milk-seller whom I will call No. 3, who, although keeping one or two cows himself, purchased a portion of the milk he supplied to his customers from No. 1 ; and two obtained their milk from a fourth milk-

seller, whom I will call No. 4, and who purchased part of his milk from No. 2. Thus out of the 50 families invaded, 47 obtained their milk supply either wholly or in part, and either directly or indirectly, from two milk-sellers, Nos. 1 and 2, whose dairies were situated close together in a street in Balsall Heath. The remaining three families did not obtain their supply of milk from any of the above sources, and their fever cases must be otherwise accounted for. They were solitary cases. One occurred at Sparkbrook, at the outskirts of the Balsall Heath district, in a place notorious for the endemicity of enteric fever, and the other brought the disease with her into Balsall Heath from a distant part of Birmingham, while the third case had an origin which I was unable to trace.

There are a large number of other milk-sellers supplying families in Moseley and Balsall Heath, even in the same streets as the invaded houses, but no enteric fever occurred among their customers so far as I could learn, with the exception of the three solitary cases above referred to.

The connexion of the outbreak with the supply of milk to the 47 families being thus traced, the peculiarities of the outbreak become explicable. Thus it is obvious why women and children, who are milk-drinkers more commonly than are grown-up men, suffered so disproportionately to the latter, why certain houses were invaded while other closely adjoining houses similarly circumstanced as regards local conditions escaped, and why multiple cases occurred together or in quick succession in nearly half the families invaded.

Other facts not hitherto mentioned also become explicable, and add confirmation to the view adopted. One of the first persons attacked with the fever was a boy who assisted milkman No. 1 in his business. He was attacked about the same time as the first of the invaded families which No. 1 supplied. About three weeks later, the family of milkman No. 3, who obtained part of his milk from No. 1, was also invaded with the fever in the person of another boy, a son of the milkman. Both these boys drank abundantly of milk.

I think it clear that the milk supplied to the 47 families, and which gave them enteric fever, was infected with the virus or contagium of that disease. It remains to be shown how the milk acquired this infection, and for this purpose I must enter into some detail.

The accompanying plan (*see* p. 95) of the block of premises in which the dairies of milkmen Nos. 1 and 2 are situated in great measure explains itself.

It is to be remarked that the entry to the yard adjoining the dwelling A belonging to milkman No. 1 is closed by a door ; but that the entry I to the joint-yard of the dwellings B and C is not so closed, but that at all times, both by night and by day, there is free access to it from the street. The pump E is used by the family of milkman No. 1 alone. The pump F is used jointly by the family occupying dwelling-house B, and by that of the milkman No. 2, occupying dwelling-house C.

Milkman No. 1 did not keep cows upon his premises, but purchased the milk which he supplied to his customers from a farmer in the country, a few miles beyond Moseley. The milk thus purchased was in part distributed to customers on the journey home, the remainder being for sale at the dairy in Balsall Heath. In consequence of a communication which was made to me by the surgeon who attended the boy who was taken ill at this milkman's house as mentioned above, and who subsequently died, I called upon the boy's mother, and she told me that on two occasions, once before his illness and once during his illness, he

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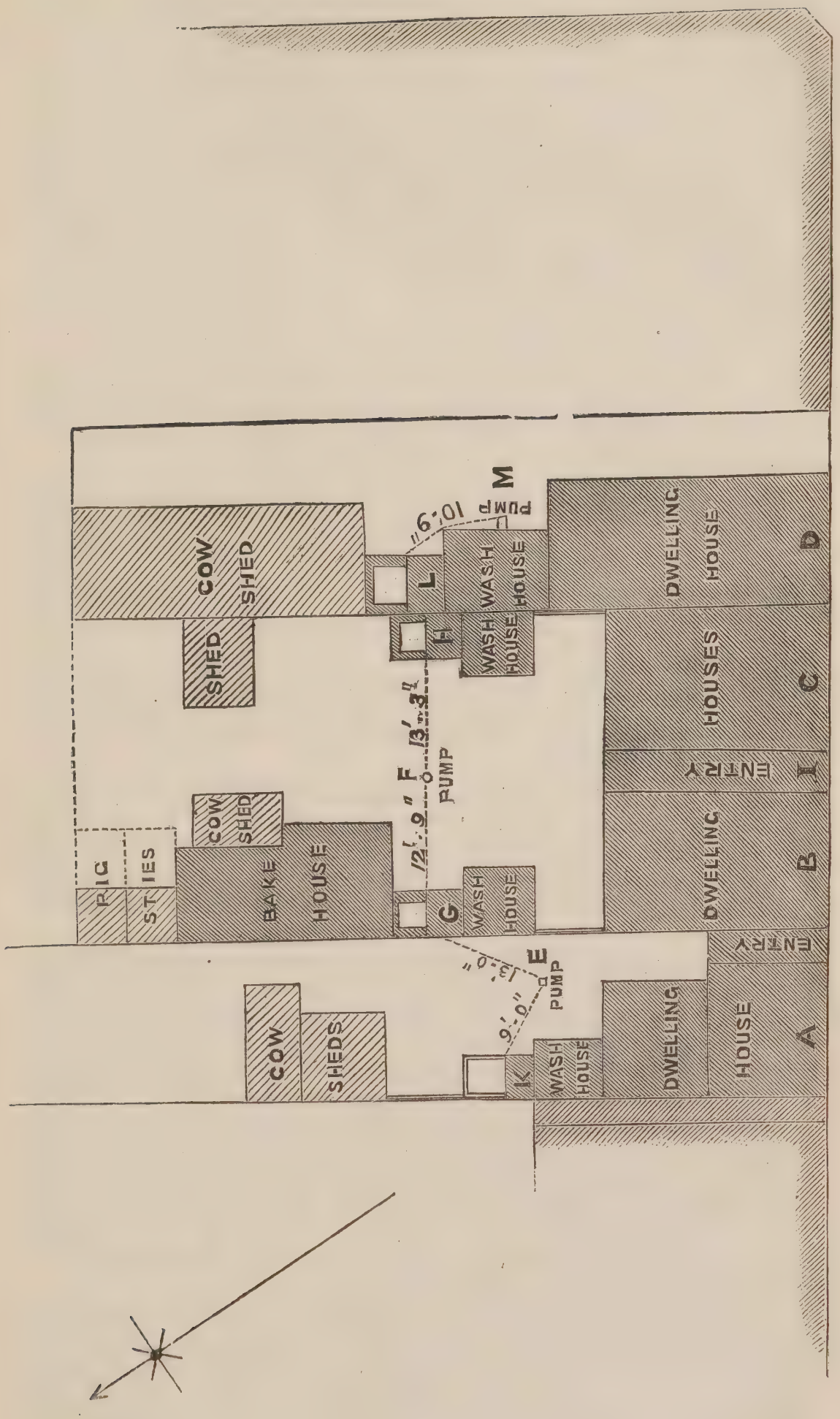
Enteric Fever, at Moseley and Balsall Heath, by Dr. Ballard.



Scale 22 feet to 1 inch.

had informed her that water from the milkman's premises was added to the milk before its distribution. Milkman No. 2 also kept no cows at his premises, but purchased the milk he supplied from a farmer, and he also distributed the milk to his customers in a similar manner to No. 1. Milkman No. 2 made no profession to me of selling milk absolutely pure; and, although I have no positive evidence that the milk sold was watered, I think it not unlikely that he followed the ordinary custom of the trade in this particular. There had been no enteric fever on the premises of either of the farmers who supplied these two men. That the source of the infectious matter in the milk of No. 1 was independent of the farmer's premises is shown by the fact that this same farmer supplied from his premises two other milkmen, one at Acock's Green, and one at Aston, and that no enteric fever had appeared among the customers whom they supplied.

My attention was thus directed to the wells marked E and F on the plan. Both wells are situated within a few feet of pervious ashpit privies, are superficial, and are sunk in the porous earth which overlies the clay in this situation. Both wells were opened and examined, and samples of water from each were taken for analysis.

Well E supplying the water used by the family of milkman No. 1 is situated 9 feet from the ashpit privy K of his premises, and 13 feet from the privy G, belonging to the next house B. The surface of the yard about the pump was bricked; beneath the bricks was a layer of clay 1 foot deep, and beneath the clay there was an imperfect wooden cover. On the well being opened its sides were found to be constructed of bricks loosely laid together, and they were deeply stained all round inside. The total depth of the well was 12 feet, and there were 8 feet of water in the well; the surface of the water was, therefore, 4 feet below that of the yard. The statement was made that the water is cloudy in rainy seasons.

Chemical analysis, the details of which are given in the Appendix to this Report, demonstrates that the water (No. 1) of this well was largely polluted with elements which it could only have derived from sewage or excremental matters, and which, there can be no question, reached it by soakage through the earth from the neighbouring midden privies.

Well F, supplying the water used by the families occupying dwelling-house B, and by that of the milkman No. 2, was very similarly circumstanced. It was situated about 13 feet from the ashpit privy G, and about the same distance from the ashpit privy H, belonging to the milkman's house, on to which privy adjoined another privy, belonging to the next dwelling-house D. As might have been expected from the greater facilities for pollution from privies of similar construction to the former, the water showed on analysis (see Appendix, analysis No. 2) evidence of excremental pollution greater in amount than that in well E. It was similarly constructed to well E, but the water quite reached the cover. The total depth of the well was 16 feet 6 inches, the depth of the water 12 feet 10 inches, and the distance from the surface of the yard to that of the water 3 feet 8 inches.

The dwelling-house and dairy D, belonging to another milkman who kept cows, was also provided with a well and pump, marked upon the plan, situated very close to the combined privies of the dwellings C and D. As this milkman had no fever cases among his customers I did not think it necessary to examine the well or its contents, which, how-

ever, could scarcely fail to be as much polluted by ordinary excremental matters as his neighbours' wells.

Subsequently to November 30, if not a little earlier, the well of milkman No. 1 might have been infected by soakage from the privy K, which was used by the boy who had enteric fever at the milkman's house, but who, after having been ill about a fortnight there, and having during that time suffered from diarrhœa, went home and died of enteric fever on December 25. But observing that the earliest cases among the customers of both milkmen Nos. 1 and 2 occurred simultaneously, or nearly so, with this boy's attack, and allowing for the ordinary period of incubation of the fever, the cause of the illness among all these persons must have been in operation as early as about November 14, and the probability becomes very great that the infection of the boy and of the first attacked customers was derived from the same source.

I have stated above that there was nothing to indicate any injurious quality in the milk as it was originally supplied by the farmers; whereas, after reaching the milk-sellers, it was liable to be mixed with water from a manifestly dangerous source. The wells of both milk-sellers are so related to privy G that they might both have received excremental soakage from it, and both of them to nearly the same extent; and they might further have both of them received infection, if infectious matter had entered privy G. Further, I have stated that the milkman residing in dwelling-house D, whose well could not fail to have been greatly polluted with ordinary excremental matters, but which was much further removed from privy G, had no enteric fever among his customers. The inference to be drawn from all the foregoing considerations is,—1st. That the source of the infection of the milk of the two milk-sellers Nos. 1 and 2 was not on the premises of the two different farmers who supplied them. 2nd. That it was to be looked for on the premises of the milkmen themselves. 3rd. That the wells of both milkmen were probably polluted from the same source, namely, privy G, and the water of these wells being added to the milk, either intentionally or accidentally, was the medium of carrying infectious matter to their customers.

It only remains now to be shown that privy G had been itself infected prior to November 14 with the infectious matter of enteric fever. Such an event appears actually to have happened.

A man residing at the dwelling-house marked B on the plan, died there from what I believe was enteric fever on November 23. This man had diarrhœa from November 3, and was seized on the 17th with rigors, marking probably the commencement of the fever. His evacuations were thrown into the ashpit of the privy marked G on the plan. This case was regarded by the medical attendant as one of dysentery, but probably it was truly of the nature of enteric fever.*

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* The history of this case as given me by the medical attendant was as follows:—The patient was an old man, aged 70, a master baker by trade, who resided in the same house with his wife, aged 65, and his daughter, aged 27. On Sunday, November 3, he visited his son in Birmingham, and after partaking of an ordinary dinner with him, had great pain in his bowels as he returned home. He had diarrhœa for several days, but as he frequently suffered in this way, he took no more notice of it than to use domestic remedies. He had some medicine at the surgery on the 8th. On the 11th he was visited and was found still to have diarrhœa, with pain in his bowels. The diarrhœa (though occasionally better) got worse, and he became

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Enteric Fever at Moseley and Balsall Heath, by Dr. Ballard.

The etiology of the outbreak of enteric fever at Moseley and Balsall Heath may, in my opinion, be thus summed up:—

1. Two wells upon adjoining premises occupied by milk-sellers, became infected early in November with the infectious matter or virus of enteric fever through the soakage from a privy into them of excremental matters containing that matter of infection.

2. Through the medium of water drawn from these wells the milk supplied by these milk-sellers became infected, and many of their regular customers who drank the milk suffered from the disease.

3. The same infected milk having been sold to two other milk purveyors, some of the persons using the milk supplied by these milkmen also suffered in a similar manner.

4. There is no evidence that the disease spread in these districts in any other way than through the consumption of these infected milks.

Through the kindness of Mr. Ross Jordan of Moseley, and Mr. Turner of King's Heath, I have, however, had an opportunity of investigating a localized outbreak of enteric fever in Beoley Lane, about a mile out in the country beyond Moseley, which was, in fact, an offshoot of the Moseley outbreak. In this lane, and distant a quarter of a mile from any other dwellings, is a row of five cottages, occupied by labouring people and their families, and a few yards from the row an isolated cottage standing in some garden ground. Numbering the cottages in the direction of the slope of the land from above downwards, the first case of fever occurred at No. 2 on January 4 in the person of a boy aged 17 years. On this day the initiatory rigors and headache were observed, and his medical attendant was sent for on the 6th. It is said that he had rose spots, diarrhœa, and elevated temperature. His convalescence commenced on the 27th, and when I saw him on February 12 he was merely suffering from debility. This boy had not been from home except to his work at some rolling mills, nor had he taken any meals from home except at the mills. None of the workmen there had fever either previously or subsequently to his illness, nor had there been any enteric fever in the neighbourhood. No fresh case occurred in these cottages until January 20, when a girl aged 16, who had not been from home for a fortnight, was taken ill at No. 5. When I saw her on February 12 she was severely ill with enteric fever characteristically marked. On January 31 a child aged four years was taken ill at No. 4. She had not been from home for a long time previously, and was ill in bed with marked enteric fever when I saw her on February 12. Her mother states that another girl of the family, who looked weak and ill,

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feeble, and took to his bed. On the 17th he was seized with intense shivering and "dysenteric" diarrhœa, passing blood, with mucus, pus, and feculent matters of an intolerably offensive character, many times in the day. There was general abdominal tenderness and fulness, but chiefly on the left side. He was never hot, except when in violent pain; and his wife stated that there was, on the contrary, a tendency to coldness during the whole illness; but no thermometrical observations were made. No typhoid-spots were observed, although the abdomen was examined every day. The medical attendant says he believes he should have seen them had they been present, although he did not specially look for them. There was no marked delirium, and only a little wandering during the day or two before death. "The man died collapsed from exhaustion and loss of blood."

The case was an obscure one, but on reviewing the above history there is nothing to preclude the notion of its having been one of enteric fever, while the character of the evacuations, and the hæmorrhage sufficient in amount to occasion fatal exhaustion, throw the balance of probabilities in that direction.

had had a slight attack of a similar character. On February 1 a woman aged 47, who was a chronic invalid and never left the house, was attacked at No. 5, being thus the second case in this house, and she was ill in bed with the fever when I saw her on the 12th. On February 5 a girl aged nine years was attacked at No. 1, and on the 10th another girl aged six years. I saw these two children ill in bed on the 12th with enteric fever. Thus, out of the five cottages in the row, all had been invaded by February 12, with the exception of one which was occupied by three adult labouring men. No case of fever had occurred at the isolated cottage beyond No. 5, occupied by three females, aged respectively 55, 18, and 12 years.

It appears that the person occupying No. 1 is a laundress, and did all the washing for a family in Moseley, in which a fatal case of enteric fever had occurred. The only person in that family who had suffered was a servant, who was first seen by the medical attendant of the family on December 11, but who had been ill some days previously. I saw her with well-marked enteric fever on January 8, and she died from that disease on January 11. During the greater part of the time that this young woman was under medical care, the evacuations were all carefully disinfected with carbolic acid, and the soiled linen which she had used was, before being sent to the wash, soaked in a Condy's solution, and I have ascertained was so received by the laundress. But in the earlier stages of the illness, before she was seen by a medical man, and for a week subsequently, no disinfectant had been used. I have ascertained that, during the week before she was first seen by the medical man, she suffered much from diarrhœa, and that on Monday, December 9, linen soiled with her diarrhœal discharges and not disinfected was sent to the wash.*

The five cottages in Beoley Lane have in common, at the rear, a yard imperfectly paved with bricks, and along this yard, parallel with the cottages, runs a narrow channel, constructed of two rows of bricks meeting at an obtuse angle. This channel, on reaching the third house, turns off to a gully 3 feet from the well, and provided below with a receiver constructed of bricks loosely laid and puddled round the sides with clay. In passing to the gully the channel crossed the top of the well, the imperfect wooden cover of which was found on examination to lie only $1\frac{1}{2}$ inches below the channel, the intervening space being filled with clay and ashes through which water might percolate. The brickwork over the rest of the well was loose, and permitted water to sink through between the bricks. From the receiver beneath the gully a badly constructed small brick drain carried off the overflow. The well was sunk in gravel and loosely bricked round; the brickwork within showed no marks of staining by percolation. The total depth of the well was 10 feet 4 inches from the surface of the yard; the surface of the water was 4 feet 10 inches below that of the ground, and the depth of the water was 5 feet 6 inches. All the slops from Nos. 1, 2, and 3 in the row, with the exception of chamber slops, are habitually thrown into the channel at the rear, and partly soak into the earth at the angle of the channel and partly flow to the gulley. The suds from the washing of the infected clothing washed at No. 1 might, therefore,

* This fact is on the evidence of the laundress, to whom the girl, who had not then gone to bed, apologised for the stained condition of her linen, saying that the diarrhœa was such that she could not help it.

have percolated into the well, and probably to some extent they did so. That percolation was possible is further shown by the evidence of the mother of the girl ill at No. 5, who says that at times the well water has been actually white after a washing day at No. 1. The infected evacuations also from the first case in the row at No. 2 were thrown into a midden privy only about 7 yards from the well, and probably assisted to infect the water through the permeable soil. The slops were thrown, as in the case of No. 1, into the channel at the rear. Up to the date of my visit to the cottages on February 12 no case of fever had occurred at the isolated cottage, although the occupants used the water from the same well. They say, however, that they never drank it cold, but only when made into tea. This cottage has a well of its own, but the water is so polluted from a privy within a few feet of it that it has been disused for a long time.

There can be no doubt that the origin of the fever in the cottages was due to the use of the well water, infected through the suds in which the infected clothing, &c., used by the fever patients in Moseley, had been washed, and that this infection first occurred in the course of th fortnight ending December 21.

On February 12 I recommended the removal of the handle of the pump connected with the infected well, and the Medical Officer of Health for King's Norton Rural Sanitary District has since informed me that this recommendation was at once carried into effect, and that a new well has been sunk and a good supply of water obtained. He informs me further that no fresh cases have occurred in any of the cottages since my visit.

At the period of my first visit to Moseley and Balsall Heath, in the beginning of January, it was evident that the spread of the fever in these places had already ceased, or nearly so. Either all the persons using the infected milk who were at the time susceptible to the operation of the virus had been attacked, or the wells upon the milkmen's premises had ceased to be infected. Nevertheless there was no ground upon which the latter alternative could be positively assured. At the same time there was yet a danger of the spread of the fever by emanations from the privies into which infected evacuations had been thrown, and by infection of the wells which derived their water from the polluted soil.

I therefore made the following recommendations for immediate adoption to the Rural Sanitary Authority of King's Norton (within whose jurisdiction Moseley is situated) and to the Local Board of Balsall Heath, at interviews which I had with these boards respectively, on January 9 and January 11:—

1. That, pending arrangements for a permanent supply of wholesome water, a temporary supply of water should be provided for the inhabitants from the waterworks of the Birmingham corporation, by means of stand-pipes, erected in convenient places; and that printed notices should be issued, recommending inhabitants no longer to use the water from their wells. In making this suggestion, I gave no opinion as to the general wholesomeness of the Birmingham supply, but advised its use on the ground of its being the best immediately available. This recommendation was at once carried into effect, so far as the provision of stand-pipes is concerned.
2. That steps should be taken to induce persons, having enteric fever

in their families, at once to disinfect the evacuations from the sick and soiled linen or articles of clothing, &c., and that the drains and privies of houses, where enteric fever had occurred, should be regularly disinfected, under the supervision of the officers of the authorities.

3. That the Local Board of Balsall Heath should adopt any means in their power to bring about the disuse of the wells upon the premises of the persons who had distributed the infection of the disease with their milk. The handles of the pumps attached to these wells were at once removed.

In addition to the above, I have to make the following recommendations for the improvement of the sanitary condition of both districts.

1. Proper sewers into which all premises may be properly drained should be provided under the direction of a skilled engineer, and, on their being provided, the dumb wells, into which domestic sewage is now carried, should be abolished.
2. Arrangements should be made for the frequent and systematic removal of the excrement of the population, in accordance with the principles laid down in the Office Report "On Means of preventing Excrement Nuisances in Towns and Villages."
3. The sanitary authorities of Moseley and Balsall Heath should provide for these places a sufficient supply of wholesome water, and, as soon as the state of the law may permit, all wells of unwholesome water should be abolished.
4. The attention of these authorities should be drawn to sections 22 to 27, and sections 37 to 39 of the Sanitary Act, 1866, which indicate the means which they should adopt, to deal with the outbreaks of infectious diseases. They should especially provide for the proper disinfection of infected houses and things, and, under the 37th section, a place of the nature of a cottage hospital, to which they may remove, under the 26th section, any persons (irrespectively of the question whether they are or are not paupers), so lodged as to be a source of danger to other persons in the same houses or neighbourhood.

Local Government Board, Medical Department,
April 1873.

Appendix.

Report on Two Samples of Water received from Dr. Ballard on January 16th, 1873. Each sample contained in two Winchester quarts. Stopper tied over and sealed; seals unbroken.

Both waters are turbid, very hard both before and after boiling, and contain a considerable amount of volatile matters and fixed salts. Both contain an excessive amount of ammonia, and also much nitrogenized matter, which, together with the high proportion of chlorine, and, particularly in the case of No. 2, the large amount of nitric acid, show very considerable contamination by sewage or surface drainage. The proportion of oxygen absorbed from permanganate is also rather high.

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Enteric Fever at Moseley and Balsall Heath, by Dr. Ballard.

The following are the details of the analysis:—

	No. 1.	No. 2.
Appearances	Turbid	Turbid.
Colour	Pale yellowish brown	Brownish.
Deposit	Slightly flocculent	Slight.
Taste	Mouldy	Mouldy.
Nitrous acid	Slight trace	Strong trace.
Phosphoric acid	Minute trace	Strong trace.
Hardness on Clark's scale	54 degrees	48·7 degrees.
„ after boiling	22·5 „	48 „
	Grains per gallon.	Grains per gallon.
Oxygen absorbed from permanganate	0·168	0·224
Total solids	70·56	131·86
Consisting of Volatile matters	16·00	32·37
Consisting of Fixed salts	54·56	99·49
Chlorine	7·35	9·31
Nitric acid ($N_2 O_5$)	2·268	11·564
Nitrogen in ammonia	0·490	0·350
Organic nitrogen	0·0420	0·0525

A. Dupré.

Westminster Hospital, January 20, 1873.

No. 6.

Report on an Outbreak of Enteric Fever in Marylebone and the Adjoining Parts of London; by Mr. J. Netten Radcliffe and Mr. W. H. Power.

This Report refers to the prevalence of enteric fever in certain districts of West London during the months of July and August last year (1873). The fact of this prevalence was first brought to the notice of the Medical Officer by Dr. Whitmore, the Medical Officer of Health for Marylebone, who submitted for consideration, and as calling for an inquiry extending over a wider area than the Marylebone district, communications made to him by Dr. Murchison and other medical men, respecting a series of attacks of households by enteric fever, apparently connected with the distribution of milk from a particular dairy. An investigation of these facts, made by one of us under instructions from the Board, and in conjunction with Dr. Whitmore and Dr. Murchison, extended to occurrences of enteric fever in 28 households, the greater number living in the districts of Marylebone and St. George's (Hanover Square), and yielded strong *primâ facie* evidence that these occurrences had been caused by the dissemination of enteric fever infection in the milk dealt out by the dairy referred to. The grounds of this conclusion and the immediate action taken upon it have been stated in a preliminary report made to the Board on the 15th August last (1873), and given in an Appendix.

In the present Report it is proposed to show the results of a more detailed investigation of the prevalence of enteric fever in the infected districts of West London during the months under consideration.

1. The inquiry extended to 244 cases of enteric fever,* distributed in 143 households. These cases all occurred during the nine weeks ending the 30th August, and, with few exceptions, they were limited to the districts of St. Marylebone, St. George's (Hanover Square), and Paddington; and there was a further limitation in St. George's (Hanover Square), to that portion of the district which lies to the north of Piccadilly; and in Paddington to that portion of the district which lies to the south and west of the Great Western Railway station.† By far the greater number, moreover, were confined to the households of well-to-do and wealthy people, 26 only happening in families not coming within this category.

* The total cases of "fever" reported to us exceeded this number, but undoubted cases of enteric fever only have been tabulated. The cases not considered were chiefly cases of undefined ailments or of diarrhœa, occurring in families exposed to the special cause of enteric fever presently to be described.

† Districts.	Households with Enteric Fever.	No. of Cases.
St. Marylebone	77	145
St. George's, Hanover Square	30	50
Paddington	23	32
Hampstead (Belsize Park)	1	1
St. Pancras (Regent's Park)	3	3
St. Anne, Soho	8	12
Kensington (The Boltons, West Brompton)	1	1
	143	244

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Enteric Fever in West London, by Mr. Radcliffe and Mr. Power.

These cases took place at a time when there was no corresponding increase of enteric fever in neighbouring districts, and when the metropolis was, and had been for many weeks, remarkably free from the disease. They formed a well-defined localised outbreak. From the beginning of the year to the period of the outbreak, the mortality from "fever" in the metropolis kept continuously much below the average of the preceding 10 years, the average weekly deaths in this period being 24·6, as compared with an average of 46·4 during the 10 years 1863–72. While the outbreak was in progress a like low mortality continued, the average for the metropolis during the nine weeks of its persistence (from the twenty-seventh to the thirty-fifth week inclusive, ending respectively July 5 and August 30) being 27·4 weekly, as compared with 43·3 in the previous 10 years. After the outbreak, and to the close of the year, this low mortality continued, the weekly deaths once only reaching the average of the preceding 10 years, and once only exceeding it. In the fortieth week of the year the deaths were 43, the average being 42·7; in the forty-third week of the year the deaths were 55, the average being 49·0.

The state of enteric fever in the affected districts previous to the outbreak was similar to that observed in the rest of the metropolis. There was a general concurrence of medical opinion as to their freedom from the disease during the preceding six months. The returns of patients received into the different metropolitan hospitals to which fever cases from West London are commonly sent, were confirmatory of this opinion. Of 201 cases of enteric fever admitted into these hospitals within the period named, 26 only came from St. Marylebone, St. George's (Hanover Square), and Paddington.* The returns of deaths from fever for the three districts further confirm the conclusion which follows from the foregoing considerations.

From the first to the twenty-fifth week inclusive, the number of deaths in St. Marylebone was 19, as compared with an annual average of 31 for the same period during the five years 1868–72; in St. George's (Hanover Square), the number was 16, as compared with an annual average of 18·2; in Paddington, the number was 11, as compared with an annual average of 20·4. During the eight weeks preceding the outbreak the mortality from fever in St. Marylebone was 8, this being a fraction under the annual average number of deaths for the same period in the previous five years, namely, 8·6. In St. George's (Hanover Square), the deaths from fever in the corresponding weeks were 2, the average number annually, during the like period of the five preceding years, having been 6·6. In Paddington, the deaths were 4, as compared with an annual average of 4·6.

The returns of mortality confirmed the results of inquiry that the outbreak was almost solely limited to the districts of St. Marylebone, St. George's (Hanover Square), and Paddington. Taking the period from the twenty-sixth week of the year (ending June 28) to the fortieth

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* The Metropolitan Asylums District Fever Hospitals at Homerton and Stockwell receive a large proportion of the fever cases occurring among the pauper class of the several Metropolitan Districts. These districts are assigned as follows:—To *Homerton*, Shoreditch, Bethnal Green, Whitechapel, St. George's-in-the-East, Stepney, Mile End Old Town, Poplar, St. Marylebone, Hampstead, St. Pancras, Islington, Hackney, Holborn, and City of London.—To *Stockwell*, Chelsea, Kensington, Paddington, Bloomsbury, Fulham, St. George's (Hanover Square), Strand, and Westminster, in addition to all districts south of the Thames.

During the first six months of the year Homerton received 37, and Stockwell 59 cases of enteric fever.

week (ending October 4) inclusive (Table I.),* so as to bring in the later deaths from the outbreak, the mortality from fever was markedly in excess of the average in St. Marylebone, St. George's (Hanover Square), and in South Paddington (Table II.), within the area of the outbreak, although in the whole of Paddington the mortality during this period was a fraction below the average. Of the districts adjacent to those chiefly affected, in one only did the mortality from fever exceed the average of the previous five years. In Kensington the mortality was slightly in excess (11, as compared with 9·6); in Chelsea it was at the average; in the remaining districts it was below. The excess of mortality in Kensington, according to Dr. Dudfield, the Medical Officer of Health, was not dependent upon any special prevalence of enteric fever in that district, and did not exceed the usual variations observed from year to year during the ordinary presence of the malady.

The mortality from fever in the districts within the affected area, during the fifteen weeks under consideration, was nearly *one-third* above the average of the preceding five years, that is to say, 45 as compared

* Table I.—Deaths from Fever in the Metropolis and certain of its Registration Districts and Sub-districts from the 26th to 40th Week, inclusive, 1873.

Weeks ending—	Metropolis.		Kensington.		Chelsea.		St. Margaret's, Westminster (Sub-district).	
	Average, 10 Years, 1863–72.	1873.	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.
June 28	39·1	20	0·4	1	0·4	—	1·0	—
July 5	41·3	24	0·4	—	0·6	2	1·0	1
„ 12	44·4	20	1·0	—	0·6	1	0·8	2
„ 19	43·3	21	0·6	—	2·0	—	0·0	1
„ 26	41·9	37	0·8	2	0·4	2	1·2	2
August 2	42·9	22	0·4	1	0·6	1	1·2	1
„ 9	41·8	25	1·2	—	0·2	—	1·4	—
„ 16	44·4	28	1·2	1	0·6	—	0·6	—
„ 23	44·7	32	0·6	1	0·8	—	1·6	1
„ 30	45·8	38	0·4	1	0·6	1	1·0	1
September 6	47·2	27	0·4	1	0·6	1	0·8	—
„ 13	49·8	26	0·8	—	0·8	—	0·4	—
„ 20	47·3	34	1·0	2	1·4	1	0·8	—
„ 27	47·6	39	0·2	1	0·8	—	0·6	—
October 4	42·7	43	0·2	—	0·6	—	1·0	1
	664·2	436	9·6	11	11·0	9	13·4	10

(*continued.*)

Week ending—	St. James's, Westminster (Sub-district).		St. Pancras.		St. Marylebone.		St. George's, Hanover Square.		Paddington.	
	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.	Average, 5 Years, 1868–72.	1873.
June 28	0·8	—	0·8	—	1·2	2	0·0	2	1·0	—
July 5	0·6	1	1·0	1	2·2	—	1·0	—	1·2	—
„ 12	0·4	—	0·8	2	1·4	1	0·0	—	0·8	—
„ 19	0·8	—	0·8	—	1·6	2	0·0	—	1·8	2
„ 26	0·4	—	2·4	1	1·8	1	0·2	1	0·4	—
August 2	0·4	—	2·8	—	0·8	1	0·4	—	0·2	1
„ 9	0·6	—	1·8	1	1·6	1	0·2	1	1·0	—
„ 16	0·2	1	1·2	2	1·6	4	0·4	2	0·4	1
„ 23	0·2	1	1·4	2	0·8	2	0·6	—	1·0	3
„ 30	0·2	—	2·2	2	1·4	2	1·2	3	0·2	—
„ September 6	0·4	—	2·2	2	1·6	3	0·6	1	1·2	—
„ 13	0·6	—	3·6	—	2·0	3	1·4	1	0·8	—
„ 20	0·6	—	2·4	4	0·8	—	0·6	—	0·6	4
„ 27	0·4	2	3·2	3	1·2	1	1·2	—	0·8	—
„ -	1·0	—	2·2	3	1·6	1	0·2	1	1·0	1
	7·6	5	28·8	23	21·6	24	8·0	12	12·4	12

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with 34·2. The mortality in the several districts was as follows:—In St. Marylebone there were 24 deaths as compared with an annual average of 21·6 for the corresponding period of the previous five years, and in St. George's (Hanover Square), there were 12 deaths as compared with an annual average of 8 for a like period. In Paddington the deaths from fever throughout the whole district were 12, as compared with an annual average of 12·4 for the corresponding period of the previous five years, but 9 of these deaths took place in South Paddington (the registration sub-district of St. John), that is to say, within the area of the outbreak. If the mortality from fever in North and South Paddington respectively be compared, the following results are obtained (Table II.*) :—The mortality in North Paddington for the fifteen weeks was 3, as compared with an annual average of 7·8 during the corresponding period of the previous five years ; while in South Paddington, the mortality was 9, as compared with an annual average for the same period of 4·6. In North Paddington, in fact, the mortality was very low, as in the rest of the metropolis outside the area of the outbreak; in South Paddington, within the area of the outbreak, it was exceptionally high. A like phenomenon was observed in St. George's (Hanover Square). Of the 12 deaths registered in that district during the fifteen weeks, 2 were of patients in St. George's Hospital who came from outside the district (1 from Chelsea and the other from Clapham), and 8 of the remaining 10 (5 of the 8 dying in St. George's Hospital) were of persons who contracted the disease within the area of the outbreak in St. George's.

Much trouble has been experienced in obtaining details respecting the different cases of enteric fever, and it has not been possible to procure these in all the cases. The outbreak occurred at a time when families of the class chiefly affected, and many medical men, leave town for the vacation. Several families carried the disease with them into the country, and it is not certain that all the instances in which this happened have been discovered. Other families sent servants, when sickening from the disease, to their homes in the country. Five of such cases were discovered, but we believe that there were other instances of the same kind. One of these cases was discovered by one of ourselves in the course of an inspection made in Buckinghamshire. This case had been sent from London to her home when the patient had been about seven days ill of

* Table II.—Deaths from "Fever" in Paddington, 1873.

Week ending		Average of 5 Years, 1868-72.		1873.	
		St. Mary (North.)	St. John (South.)	St. Mary (North.)	St. John (South.)
June	28	0·8	0·2	0	0
July	5	0·8	0·4	0	0
,,	12	0·4	0·4	0	0
,,	19	1·4	0·4	1	1
,,	26	0·4	0·0	0	0
August	2	0·2	0·0	0	1
,,	9	0·4	0·6	0	0
,,	16	0·4	0·0	0	1
,,	23	0·6	0·4	0	3
,,	30	0·0	0·2	0	0
September	6	0·4	0·8	0	0
,,	13	0·6	0·2	0	0
,,	20	0·2	0·4	1	3
,,	27	0·6	0·2	0	0
October	4	0·6	0·4	1	0
		7·8	4·6	3	9

the disease, and she died on the seventh day after reaching her home, death having probably been accelerated, at the least, by the long journey. We may remark here, in respect to the removal of these servants into the country, and assuming they had an objection to be removed to the wards of a general hospital, that both they and their masters appear to have been ignorant of the admirable accommodation for such cases in the London Fever Hospital. Such an objection, however, it is proper to remark, is exceptional, for not less than forty-three domestic servants who suffered in this outbreak were treated in hospital. These added to thirty-three cases not removed to hospital, but treated either at their places of service or at their homes in town, to the five cases discovered in the country, and to eleven occurring (in families removing from the affected districts) immediately after leaving town, make a total of ninety-two domestic servants attacked, that is to say, 37·7 per cent. of the whole number of ascertained seizures during the outbreak.

The total number of persons attacked after leaving London, and whose illness dates from before the time of their leaving, was thirty-three.

Not a few families left town for lengthened periods of absence as soon as the cases of fever in them became convalescent, and of several of these it has only been possible to obtain an authentication of the actual nature of the sickness and of its probable source.

Notwithstanding these difficulties we have got together the following particulars respecting the dates of attack, the ages, and the sex of the greater number of the cases; and we are of opinion that they fairly represent the progress of the outbreak and the peculiarities of its incidence upon individuals.

Dates of Attack in 191 Cases.

Date of Attack.	Cases.	Week ending.	No. of Cases in each Week.	Date of Attack.	Cases.	Week ending.	No. of Cases in each Week.
July 1	1			August 3	3		
,, 2	1			,, 4	7		
,, 3	1	July 5	5	,, 5	8		
,, 4	1			,, 6	9	Aug. 9	49
,, 5	1			,, 7	—		
,, 6	3			,, 8	11		
,, 7	1			,, 9	11		
,, 8	1			,, 10	2		
,, 9	1	July 12	6	,, 11	2		
,, 10	—			,, 12	2		
,, 11	—			,, 13	—	Aug. 16	7
,, 12	—			,, 14	—		
,, 13	1			,, 15	—		
,, 14	—			,, 16	1		
,, 15	—			,, 17	—		
,, 16	3	July 19	11	,, 18	1		
,, 17	—			,, 19	—		
,, 18	4			,, 20	2	Aug. 23	3
,, 19	3			,, 21	—		
,, 20	13			,, 22	—		
,, 21	5			,, 23	—		
,, 22	8			,, 24	—		
,, 23	6	July 26	50	,, 25	1		
,, 24	8			,, 26	—		
,, 25	2			,, 27	—	Aug. 30	1
,, 26	8			,, 28	—		
,, 27	4			,, 29	—		
,, 28	15			,, 30	—		
,, 29	1						
,, 30	3	Aug. 2	59				
,, 31	14						
August 1	10						
,, 2	12						

Sex of 148 *adult* cases, and number of *children* attacked:—

Men	29	148
Women	119	
Children		96

Ages of 179 of the attacked:—

Under 5 years	14	20 and under 25 years	29
5 and under 10 years	35	25 „ 30 „	19
10 „ 15 „	29	30 „ 40 „	16
15 „ 20 „	29	40 years and upwards	8

Among the entire number of 244 cases, 26 deaths were ascertained to have occurred, 11 of which do not appear in the mortality return of the affected districts, 4 of these having taken place in the country, and 7 in hospitals situated in other districts of the metropolis.*

As already mentioned, the outbreak was almost entirely confined to the districts of St. Marylebone, to that portion of St. George's (Hanover Square), which lies to the north of Piccadilly, and to that portion of Paddington which lies to the south and west of the Great Western Railway station. There was a certain scattering of cases in the neighbouring districts of St. Pancras, St. Anne's, Soho, and Hampstead, which will be more fully described hereafter. Within the area of prevalence the disease was distributed somewhat irregularly in every part. The number of localities (including streets, squares, places, &c.) affected was 88, and of these 48 had only one case in them, the rest having two or more. The localities chiefly affected were 12 in number (Seymour Street, Old Quebec Street, Norfolk Square, Grosvenor Square, Grosvenor Street, Wigmore Street, Queen Anne Street, Wimpole Street, Nottingham Place, Gloucester Place, Lancaster Gate, and Granville Place), and in them occurred 108 cases, the remaining 76 localities having 136 cases. 76 houses had solitary cases, 67 houses had two or more cases.

2. In endeavouring to elucidate the causes of this outbreak of enteric fever, of its peculiar localisation, and of its limitation to a particular class of the population, attention was first given to the conditions of sewerage, drainage, and water supply of the affected districts and houses. The results of the investigation in these respects may be thus stated:—

As to Sewerage and Drainage.—(*a*) About one-tenth of the whole number of cases occurred in houses where there were obvious or presumed defects of drainage which might account for their existence. Among these cases was a group in one mansion which followed upon, and may have been determined by the importation of a case into the household from the Continent.

(*b.*) Certain other cases and groups of cases occurred in houses where some imperfections of drain traps were discovered, and a direct connexion of the waste pipes of the drinking water cisterns with the sewers. The suspicion was at first excited, particularly having regard

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* Of those dying in the country, 2 from Marylebone died, 1 at Chipping Norton, the other at Dolgelly; 1 from St. George's died at Windsor; and 1 from Paddington died at Brill, Bucks. Of those dying in hospitals out of affected districts, 5 from Marylebone died, 1 in each of the following hospitals: London Fever Hospital, Islington; St. Bartholomew's Hospital, City; University College Hospital, St. Pancras; King's College Hospital; and the Metropolitan Asylum District Board Fever Hospital, at Homerton; 1 from Paddington died in University College Hospital; and 1 from St. George's, Hanover Square, died in St. Mary's Hospital, Paddington.

to the number of domestic servants attacked, that these cases also owed their origin to a probable pollution of the atmosphere, particularly in the basement of the houses, and of the water supply of the houses with sewer air. But as the inquiry proceeded it was found impossible to reconcile this view with the peculiar limitation of the disease to well-to-do and wealthy families occupying the most commodious houses in the affected districts. For the defects noted were common to these houses and to large numbers of neighbouring less commodious houses occupied by other and poorer classes of the population, the inhabitants of which wholly escaped the outbreak.

(*c.*) The greater number of cases occurring in certain streets, particularly in St. Marylebone, suggested that some temporary defects of main sewerage might be at the bottom of the outbreak; and information was communicated to us of reconstruction of sewers in the localities chiefly affected in St. Marylebone. But a return of the sewerage works carried out by the vestry of St. Marylebone, which has been prepared for us by the assistant-surveyor to the vestry, Mr. Hallett, shows that the sewerage works referred to had all been completed on or about the 20th April, two months before the outbreak. The inquiry failed to elicit any evidence of defective sewers in connexion with the outbreak.

(*d.*) Several groups of cases occurred under circumstances peculiarly favourable for complete observation. In two of these groups, both of them occurring in the households of medical men, accustomed to etiological research, it was possible to put aside, with as great a certainty, perhaps, as can ever be attained in such inquiries, the questions of pollution of the atmosphere and of the water supply of the house with sewer air. In each instance the drainage of the house had, some time before the outbreak, been placed in as thorough order, with special reference to the exclusion of sewer air from the interior and from the water cisterns, as sanitary science could teach and good workmanship and supervision command. So far as human foresight could provide, both houses were sealed against enteric fever, and, unless the disease were contracted away from home, the households were secure against the malady. In one of these households three cases, and in the other six cases, of enteric fever occurred, in each instance determined, apparently, by the same cause (whatever that might be), acting about the same time. The probability of the disease having been contracted away from the houses by any one of the sufferers in either household could be set aside with almost absolute certainty; but any doubt which might rest upon this matter was, by the circumstances of the cases, completely disposed of, as of the majority it could be confidently affirmed that it was impossible for the disease to have been contracted away from home.

Another group of cases, also taking place in the family of a medical man, occurred during the outbreak under the following circumstances: —Earlier in the year five members of the family had suffered from the disease. These cases were attributed to marked imperfections in the drainage of the house. On their recovery the family left town for a time, and during their absence the drainage of the house was put into thorough order. Shortly after returning home three other members of the family were attacked with the disease. The dates of seizure forbid the supposition that they had contracted the malady whilst in the country. The recent rectification of the drainage of the house appeared equally to forbid the assumption that the disease had been occasioned by defects of drainage. Further, it was improbable that the disease could have been contracted elsewhere in the metropolis.

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A fourth group of cases took place in a charitable institution for young children. 18 out of 30 of the little inmates were attacked. Two apparently disconnected cases preceded the wider prevalence in the establishment, and at once gave occasion for the most careful examination of the sanitary arrangements of the building by the medical attendant. These were found to be unimpeachable. Two years before, a solitary case of enteric fever occurring among the children alarmed the managing committee. As a consequence the whole of the drains of the building had been reconstructed, and the rain pipes, waste water pipes, and sink pipes cut off from direct communication with them. In the spring of the present year the building was put in order throughout, and, among other things, the state of the drain inlets, and of their traps, and of the water closets was seen to. In the interval of these structural repairs the sanitary state of the building was under the constant supervision of the medical attendant; and he was able to determine fully that at the time of the outbreak among the children the drainage arrangements and the water supply were, and had been for some time, in perfect order.

The foregoing considerations appear to us to lead irresistibly to the conclusion that defects of drainage will account for a very small proportion only of the cases which occurred during the outbreak which forms the subject of this report.

As to Water Supply.—The question of a pollution of the water supply in the several houses affected with enteric fever has been dealt with in the previous section. We have here to consider the questions of pollution of the general water supply and of local branches of supply. Both these questions admit of being very briefly touched upon. The area of the outbreak was within the districts of two metropolitan water companies, the West Middlesex and the Grand Junction. The area occupied a small segment of the last-named company's district, and a much larger portion, but far from the whole field, of the first-named company's district. Both companies take their water from the same point of the Thames. The distribution of the cases, indeed, proves that there was no general infection of the water supply.

One of us had in mind the accidental pollution by sewage, several years ago, of a local branch supply of one of the companies named, and, notwithstanding the extreme improbability of concurrent and adjacent local pollutions in the districts of the two companies, inquiry was made as to the occurrence of any such pollution during the outbreak under consideration. There was not a particle of evidence to show that pollution of any branch supply had happened, either at the time or immediately before the time of the outbreak.

3. Still proceeding by a process of exclusion it was necessary to examine the relations which the outbreak might have to the considerable prevalence of diarrhœa in the metropolis about the same time, and to certain meteorological phenomena. (*See* Appendix, Table I., Diagrams 1 and 2). It seemed probable that we might thus, indirectly, gain some light upon the main object of the inquiry. The mortality from diarrhœa in the metropolis, which had steadily remained below the average of the preceding 10 years until the 30th week of the year (ending July 26), went largely above the average in the 31st and 32nd weeks (ending August 2 and August 9 respectively), and kept steadily above it until the close of the 41st week (ending October 11). This augmentation of the mortality of diarrhœa above the average followed close upon certain well-defined meteorological changes.

According to the Greenwich observations, as summarised by Mr. Glaisher in the Registrar General's quarterly returns, we learn that

" from the 22nd day of April a long cold period set in, and the weather " continued, with but few trifling exceptions, continually below the " seasonable average till the 18th day of June. For this long period " of 57 days the deficiency of mean was, on the average, $2\frac{3}{4}^{\circ}$ daily. " On the 19th of June a warmer period set in, but not uninterruptedly, " for four out of the remaining 12 days were of lower temperature than " was due to the season. Upon this period of 12 days there was a " mean excess of daily temperature of $1\frac{1}{4}^{\circ}$." The mean temperature of the month, 58·9°, was 0·7° higher than the average of 102 years; the daily range of temperature was less than the average by 1·0°. Frequent movements of the barometer occurred in June, but only to small amounts, and the mean reading of the month (29·794) was 0·020 below the average. The prevalent winds were southerly and south-westerly, and the rainfall (2 inches) was 0·7 in excess.

The following month, July, the weather till the 19th " was mostly " cold, and the mean daily temperatures were below their seasonable " averages by $\frac{3}{4}^{\circ}$. On July 20 a sudden change took place, and for a " few days the weather was fine and hot, particularly on the 21st, " 22nd, and 23rd, the mean temperature of those days being 71·7°, " 75·2°, and 72·3°, exceeding their averages by 10·2°, 13·7°, and 10·7° " respectively. Immediately following these four warm days, beginning " July 20, 1873, the weather was again cold, and from July 20 to " September 2 the weather was changeable, the whole period being " characterised by several days of warm weather, followed by a few " days of cold, and then succeeded by several warm days again; the " warm days were, however, the more numerous, and upon the whole " period there was an excess of temperature averaging $2\frac{1}{2}^{\circ}$, on the 45 " days ending September 2." The mean temperature of July, 63·4°, was 1·8° higher than the average of 102 years, and $4\frac{1}{2}^{\circ}$ above that of June; the daily range of temperature during the month was greater than the average by 1·7°. The readings of the barometer were very variable throughout the month, but the movements were not of very great magnitude; the mean reading (29·792) was 0·015 below the average. The prevalent winds were south-westerly, and the rainfall (2·5 inches) was the average.

The sudden and great increase of temperature from the 20th to the 23rd July inclusive was immediately followed by a large augmentation of diarrhœa, marked by a considerable leap of the mortality from the disease in the week following (ending August 2) to 51 above the average of the previous 10 years; and the continuation of the high temperature was accompanied by a still greater augmentation in the next week after (ending the 9th August), when the deaths were 470, as compared with an average of 273·5 during the 10 years 1863–72. The mortality for diarrhœa continued above the average eight weeks following the week last named.

St. Marylebone, St. George's (Hanover Square), and Paddington, suffered from this increase of diarrhœa, as the rest of the metropolis. The mortality from diarrhœa in St. Marylebone exceeded the average of the previous five years, from the 31st to the 35th week, and again from the 37th to the 39th week inclusive; in St. George's (Hanover Square), it exceeded the average in the 32nd, 33rd, 34th, 36th, and 40th weeks; and in Paddington the 30th, 31st, 32nd, 34th, 35th, and 38th weeks.

The conditions which proved so favourable to the development of diarrhœa throughout the metropolis generally, were not correspondingly favourable to the development of enteric fever. As already stated in the first part of this report, the mortality from " fever " was remarkably low throughout the whole period in question, until the 40th week, when the average was reached. It had been, as a rule, largely below the average in each of the previous weeks of the year. The 40th week,

when the deaths from "fever" reached the average of the preceding 10 years, was the last week of the mortality from diarrhœa remaining above the average. But that the prevalence of enteric fever was not uninfluenced by the high temperatures of July and August, is to be inferred (making due allowance for period of incubation and sickness) from the steady increase of mortality from "fever," with one fluctuation, from the week ending the 20th September to the week ending the 25th October, the only week in which the mortality exceeded the average throughout the year.* (*See* diagrams, Appendix.)

If, now, the progress of the outbreak in St. Marylebone, St. George's (Hanover Square), and Paddington, be compared (*see* Diagram, Appendix) with the meteorological phenomena which have been described, and with the progress of "fever" and diarrhœa throughout the metropolis, as gathered from the mortality caused by the diseases included in these terms, very marked differences are observed. First, it will be noticed, on reference to the dates of attack, that the beginning of the outbreak preceded by three weeks the great increase of temperature in July, the cause of the first seizures dating from a still earlier period. Next, the greatest number of seizures were crowded together in the three weeks of highest temperature, those ending the 26th July, 2nd and 9th August, in which weeks the great development of diarrhœa occurred, and the increasing prevalence of "fever" began in the metropolis generally. The crowding together of the seizures within these three weeks proves that the cause producing them was principally active during the preceding three weeks. Further, the outbreak quickly declined, and came to an end before the augmentation of the disease in the west of the metropolis could be definitely measured.

The phenomena of the outbreak, as to its inception, its rapid progress and development, and its quick decline, were quite apart from the phenomena of the progress and decline of fever elsewhere in the metropolis. These facts, and especially the circumstances that the outbreak preceded those local changes of temperature which so obviously determined the great prevalence of diarrhœa and affected the course of fever in other metropolitan districts, tend to confirm the conclusion which is to be derived from the considerations advanced in previous sections that the outbreak was not of local origin. It is to be inferred that, if the outbreak had been to any marked extent dependent upon local defects of sewerage and drainage, that the evil influence of these imperfections would have been exaggerated and prolonged by the excessive temperatures of July and August. The observed facts of sewerage and drainage in reference to the outbreak, and the relations of the outbreak to the movement of "fever" elsewhere in the metropolis, and to the meteorological phenomena of the period, concur in showing that its origin must be looked for in some cause other than one of local origin.

4. To this point the detailed investigation has confirmed the accuracy of the provisional conclusions of the preliminary inquiry. It now remains to be seen whether the ultimate conclusion of that inquiry is sustained by the additional and more closely observed facts collected. We have exhausted the known conditions which foster or determine the prevalence of enteric fever with one important exception, namely, the possibility of distribution of the infective material of the disease with some article of food. According to present experience this question is limited to the distribution of the infective material in *milk*.

Early in the outbreak Dr. Murchison, whose family suffered very

* The excess of the mortality registered from "fever" during the week ending the 25th October (55 as compared with 49) was probably an accidental circumstance connected with registration. The average mortality from "fever" of the three weeks of which it was the middle was 43, as against a decennial average for the same three weeks of 50.

severely from it, satisfied himself that the only probable mode of introduction of the disease into his house was by the milk supply. The suspicion having been aroused, he quickly ascertained that almost the whole of the families which were then affected with enteric fever within his knowledge and that of his professional friends, obtained their milk from the same dairy which supplied his household. The information as to these cases, communicated by Dr. Murchison to Dr. Whitmore, and by the latter gentleman to the Medical Officer, formed the groundwork of the preliminary departmental inquiry. Dr. Whitmore continued the investigation begun by Dr. Murchison, within the area of his own district and discovered much to confirm Dr. Murchison's conclusion. We have now to state the results of our further inquiry concerning this question, including the facts collected by Dr. Murchison and Dr. Whitmore, also by Dr. Corfield, and aided by the books of the implicated dairy, placed freely at our disposal for use in the inquiry by the proprietors, who, it must be added, in other ways also rendered us important assistance.

(*a.*) Of the 244 cases of enteric fever to which the inquiry extended, 218 (that is to say, *nine-tenths*) were in households which consumed milk obtained from a particular service of a particular dairy. The proportion of cases thus occurring in households using a particular milk-supply rendered it probable that the connexion between the milk-supply and the prevalence of fever was not casual.

(*b.*) This probability was strengthened by the progression of the cases in households having milk from the particular service, as contrasted week by week, with the cases in households having milk from other sources. This is shown in the following Table, compiled from the ascertained dates of attack:—

Table III.

Weeks ending	No. of Cases.	Of these there were	
		In Households taking Milk from the particular Service.	In Households not taking it.
July 5	5	1	4
„ 12	6	2	4
„ 19	11	11	0
„ 26	50	49	1
August 2	59	53	6
„ 9	49	46	3
„ 16	7	5	2
„ 23	3	0	3
„ 30	1	0	1
Total for 9 weeks	191	167	24

(*c.*) The disproportionate growth of cases in households having the particular milk-supply, as compared with those occurring in households not having this supply, shown in the foregoing Table, was still more clearly observed in the cases of enteric fever admitted into the different hospitals receiving cases from the affected districts; and the probability that this predominance was directly connected with the milk-supply was proportionately confirmed. The following Table (*Table* IV.) refers to cases of enteric fever received into certain London hospitals from the 1st January to the 1st September, 1873. These cases are separated into three categories. The first relates to cases received from the 1st January to the 30th June, that is to say, prior to the outbreak; the second relates to cases received from the 1st July to 1st September, that is to say, during the period of the outbreak. In the first two categories

the cases received from the localities within the area of the outbreak are distinguished from those received from localities outside this area. The third category relates to the cases received from localities within the area of the outbreak, and among these distinguishes the cases in which the patients had habitually, before being attacked with enteric fever, consumed milk obtained from the particular service of the particular dairy referred to, from the cases in which the patients had not at any time consumed milk from this scource of supply. The results of the cases thus tabulated are as follows :—

1. Of 134 cases of enteric fever received into the hospitals named, during the six months ending the 30th June, 1873, 15 only came from localities situated within the area of the outbreak during July and August, and having, in round numbers, a population of a third of a million ; 119 coming from other localities having a population of upwards of a million, and also from East London.
2. Of 141 cases of enteric fever received into these hospitals during the two months ending the 1st September, the period of the outbreak, 64 came from localities situated within the area of the outbreak and 77 from other localities.
3. Of the 64 cases noted in the previous category as coming from localities situated within the area of the outbreak, 52 habitually consumed milk obtained from the particular service of the particular dairy previously referred to, and 12 had not at any time consumed milk from this source of milk supply.

The defined character of the outbreak is shown by the very largely augmented proportion of cases received into the hospitals named, during the two months ending the 1st September, from the affected area. The probability that the great increase of cases from this area might be dependent upon the quality of the milk-supply was clearly indicated by the excessively high proportion (a proportion, namely, of 13 to 3) of patients who, previous to the time of seizure, had been accustomed to use milk from one source of milk-supply as compared with patients who were accustomed to use milk from other sources of supply.

Table IV.—Cases of Enteric Fever received into certain London Hospitals, January to September 1873.

Hospitals.	Jan. 1 to Sep. 1	Jan. 1 to June 30.			July 1 to Sept. 1.			Area of Outbreak, July 1 to Sept. 1.		
			Of these there were from—			Of these there were from—			Of these there were—	
	No. of Cases.	No. of Cases.	Area of Outbreak.	Other Localities.	No. of Cases.	Area of Outbreak.	Other Localities.	No. of Cases.	Taking Milk from a particular Supply.	Taking Milk from other Sources of Supply.
Charing Cross	6	3	1	2	3	2	1	2	2	—
Homerton	76*	37	1	36	39†	12	27	12	6	6
King's College	18	9	2	7	9	4	5	4	4	—
London Fever	32	22	1	21	10	4	6	4	4	—
Middlesex (to Sept. 13)	43	18	3	15	25	17	8	17	13	4
St. Bartholomew's	24	10	0	10	14	2	12	2	2	—
St. George's	34	15	2	13	19	8	11	8	7	1
St. Mary's	9	4	2	2	5	4	1	4	4	—
St. Thomas's	19	10	1	9	9	3	6	3	3	—
University College	14	6	2	4	8	8	—	8	7	1
	275	134	15	119	141	64	77	64	52	12

* A large proportion of these 76 cases in Homerton came from East London.

† Of 20 cases admitted into Stockwell (the other Metropolitan Asylum District Fever Hospital for pauper patients) during July and August, one only came from the area of outbreak.

(*d.*) The probability of this dependence of the outbreak upon the quality of the milk-supply among the households of the persons attacked became greater, when the distribution of the cases was examined in conjunction with the distribution of the particular milk-supply. With one remarkable exception, in Pimlico, presently to be described, wherever the milk of this supply was distributed there the cases of enteric fever which collectively formed the outbreak were distributed. Where the milk-supply stopped short there, as a rule, these cases stopped short. The map of the distribution of the milk-supply represented very closely the area of the outbreak; and that this was not an accidental correspondence was to be inferred from the following facts:—

(1.) The milk-supply in question was distributed generally over St. Marylebone, and that part of St. George's (Hanover Square) which lies to the north of Piccadilly, so also was the outbreak.

(2.) Certain ramifications of the milk-supply extended to the east side of Regent's Park, St. Pancras, to Belsize Park, Hampstead, to St. Anne's, Soho, and to several houses in St. James's, Westminster, and in these several localities, with the exception of St. James's, Westminster, the cases of enteric fever occurring during the outbreak which have come to our knowledge were, with one exception, among families having this milk-supply.

(3.) This milk-supply was also carried into South Paddington, as far west as Lancaster Gate and the streets adjacent. To this part of Paddington, and this part only, did the outbreak extend.

Here then, was an apparent explanation of the cases of enteric fever occurring during the outbreak, and obviously belonging to it, in limited parts of districts adjoining St. Marylebone and St. George's (Hanover Square). Here, again, also was an apparently sufficient explanation of the peculiar limitations of the area of outbreak.

(*e.*) Confirmatory of such an explanation was the fact that the distribution of the same milk-supply would equally explain the further and peculiar limitation of the outbreak to well-to-do and wealthy families. For this milk-supply was, with a remarkable exception presently to be mentioned, confined to such families, with the sole qualification of an occasional accidental issue by the carriers on their rounds.*

(*f.*) More direct evidence of a connexion between this milk-supply and the determining cause of the outbreak is furnished by the fact that the disease picked out the streets to which the milk was distributed, and the houses in those streets which received the milk. Of 88 infected streets this milk-supply went into 77, and of 132 infected houses in the 77 streets in which fever occurred, 14 only did not receive this milk-supply. In 118 houses out of 760 (15·5 per cent.) taking the milk there were 218 cases of enteric fever, while in the 14 houses, out of (in round numbers) 23,000 in the same area not taking the milk there were 14 cases only.

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* In the districts above mentioned, of 207 cases in connexion with this milk-supply, 4 only (not including servants) did not come within the category of wealthy and well-to-do people; while of 25 cases in the same districts not in connexion with the particular milk-supply, no less than 10 were of the poorer class. In other words, the cases among the poorer class in connexion with the milk were 1·9 per cent.; not in connexion with the milk, 40 per cent.

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(*g.*) Still more direct evidence to this end, though in its nature limited in amount, is afforded by the disease during the outbreak having picked out the members of certain families using this milk-supply who alone drank the milk "as it came from the dairy," and by the seizure of persons who had exceptionally used it. The following are examples of both kinds of facts :—

Instances of first class cases.—(1.) The mistress and the kitchenmaid were the only persons in a family who habitually drank uncooked milk : they both had enteric fever. Two children in the same family who did not take milk in this form escaped. (2.) A physician, in the habit of taking nightly half a pint or more of cold milk, "as it came from the dairy," was the only person in his household who did so ; he alone had enteric fever. (3.) Miss H., the only person in the house who drank cold milk, "drank it largely ;" she had enteric fever. Other and similar instances might be mentioned.

Instances of second class of cases.—(1.) Miss N., early in July, paid a visit to her aunt in Marylebone ; drank much milk while in town ; returned to her home in the country July 23 ; fell ill with enteric fever July 26. (2.) Of a family consisting of a lady and three servants, the lady took milk from the particular dairy in question, while the servants were supplied from another dairy. One of these servants, the cook, "now and again" drank milk left at table by her mistress, she had enteric fever. (3.) In another household the master and mistress took milk from this particular dairy, while the servants (four), obtained theirs from a different source ; one of these latter had enteric fever. She states that, "some days before she was taken ill" she drank half a pint of milk left at table by her master and mistress. There is reason to believe that in both these instances (3 and 4) the employers were middle-aged or elderly, while the servants were young persons. (4.) J. A., clerk to the dairy company in question, lived with his parents, who did not take the company's milk. During office hours, J. A. drank, he says, much milk ; early in August he was attacked by enteric fever. There not any illness among other members of his family. (5.) A child, member of a family not dealing with this particular dairy, spent an afternoon (July 19) with a family supplied from this dairy, and during the visit drank nearly two pints of milk ; on the 24th of July she was attacked by enteric fever. Of the family at whose house she spent the day 10 members were attacked by the same disease between July 21 and the beginning of August.

(*h.*) Other evidence tending to fix directly the dependence of the outbreak upon the quality of this milk-supply was furnished by numerous instances of seizures among large consumers of the milk. The following examples may be given :—

Instances. Adults.—(1.) A footman and a lady's maid, aged respectively 19 and 28, "were in the habit of drinking cold milk in considerable quantities during the hot weather ;" both had enteric fever and the footman died. They were the youngest of a household of six persons. (2.) A kitchenmaid in a family of six persons, all adults, "did not drink beer, but often took draughts of milk ;" she alone of the family was attacked by enteric fever. (3.) A cook, aged 20, was fond of milk and "often drank the milk left at table ;" she alone, of a family of six adults, had enteric fever. The other servants, she says, "did not care for milk." (4.) A servant, aged 40, was in the habit of drinking much milk ; she alone, of all the adults in the family (11), had enteric fever. Of three children in the same family two had enteric fever. (5.) A servant, aged 22, "was very fond of milk and often drank it cold ;" she would drink the milk left at table ; she died of enteric fever. Of two children in the same family, one, who was particularly fond of milk, and who often drank it "as it came from the dairy," also had enteric fever, but, after severe illness, recovered. (6.) A servant, aged 17, was a great milk drinker, and habitually drank the milk left at table, she died of enteric fever. A child in the same house was also attacked, but recovered. (7.) Two servants, each aged 23, were great milk drinkers ; one "was in the habit of drinking much milk, as she did not take beer ;" the other "was very fond of milk, and often drank it cold in hot weather." These servants were the only members of a

family of 12 adults attacked by enteric fever. (8.) In a family of 12 (seven adults and five children) the nursemaid (aged 17), "like the children often took draughts of cold milk." This nursemaid, the cook, and four chilldren, had enteric fever. (9.) A butler, who was a teetotaller and a great milk drinker, was attacked by enteric fever and died. (10.) A clergyman who was a milk drinker, took habitually two tumblerfuls of milk daily: he died of enteric fever. Other instances of the incidence of enteric fever on adults, who were large consumers of milk, could be given were it necessary.

As regards children, into whose diet milk naturally enters so largely, it has been found difficult to separate "milk drinkers" from those who did not habitually take milk in considerable quantity. Two instances may, however, be noted where a certain separation was effected. (1.) Of four children in a family, the second a girl aged five, was the only one who drank a great deal of milk; she alone had enteric fever. (2.) Of three children in another family the eldest had tea for breakfast and orange wine and water at night, the two younger ones having bread and milk for breakfast and cold milk at night; the two younger had enteric fever while the eldest escaped. In this family a butler, "who had beer money but saved it," had also enteric fever.

(*i.*) The assumption that this milk-supply occasioned the outbreak was consistent with the facts of the large number of women and children, and the small number of men affected by it.

The cases first observed were among children and women using a special milk issued from the dairy, and known as "nursery milk." Of 34 individuals, 12 being adult women and 22 children, belonging to six different families, who habitually used "nursery milk," 6 of the women (50 per cent.) and 7 of the children (31·8 per cent.) were attacked with enteric fever. At first it was suspected that this particular milk was alone infected, but, as the inquiry proceeded, it was ascertained that the cases were not confined to families using "nursery milk," but that they occurred also among families using the ordinary milk distributed from the dairy. The clue furnished by the "nursery milk" would (as subsequent inquiry proved) have sufficed to conduct the search for the source of infection to a successful issue, had any obstacle arisen in carrying out the method of investigation adopted.

(*j.*) Finally, evidence confirmatory to a very high degree of a direct connexion between this milk-supply, and the outbreak was furnished by an isolated group of cases which occurred at the same time in another district of the metropolis, namely, St. Anne's, Soho. These cases first came to the knowledge of Dr. Coupland, the Medical Registrar of the Middlesex Hospital; and, seeking for information as to their cause he found that several of them stated that they used milk obtained from a branch establishment in Soho of the dairy, the milk of which was suspected to have caused the outbreak in St. Marylebone, St. George's (Hanover Square), and Paddington. An inquiry into the conditions under which this group of cases had occured, made by one of ourselves, in conjunction with Dr. Conway Evans, the Medical Officer of Health for the district in which the locality is situated, led to the following results:—The cases were 12 in number, distributed in eight families, and the persons affected, chiefly children and young people, were not of the poorest class in the neighbourhood. No local cause could be assigned for the peculiar grouping of the cases. Eleven of the patients had, however, habitually or occasionally, milk from the branch establishment referred to. This establishment had been opened chiefly for the disposal of skim milk, and its business was conducted entirely across the counter, there being no delivery from it at customers' houses. The number of families buying milk from this establishment probably did not exceed 30, and of these seven were attacked with enteric fever. It would be difficult to regard the connexion of the cases in this group through

their milk supply, even if the evidence were weaker on the whole question than it is, as a mere coincidence.

Notwithstanding the high degree of probability attached to the conclusion which appears necessarily to follow from the preceding considerations, namely, that the outbreak was directly dependent upon the quality of a particular milk-supply, before adopting this conclusion it was necessary to examine certain facts which seemed to militate against it. These were,—

1. The exemption of certain families, 63 in number not living within the area of the outbreak but within the district of a branch dairy in Pimlico, who received their milk from the implicated dairy.
2. The freedom from the outbreak of the milk carriers engaged in distributing this milk supply.
3. The entire escape of many streets within the area of the outbreak to which the service of the particular milk supply extended.
4. The irregular distribution of cases within the area of the milk supply, particularly the marked predominance of cases in some streets (already named) as compared with others.

An examination of these facts has served to confirm the accuracy of the conclusion that follows from the great body of the evidence. At the commencement of the inquiry, observation of the manner in which milk was received from the country at the implicated dairy, led to the inference that, to explain the then known facts of the outbreak, it was not necessary to assume that the milk from more than one of the several farms from which the dairy obtained its supplies was infected with enteric fever material. This assumption has been fully justified by the results of further investigation. Such investigation has shown, as will be related in another part of the Report, that the infected milk came from a farm which, in addition to supplying somewhat over one-sixth of the ordinary milk received by the implicated dairy, supplied also the whole of the so-called "nursery milk." This last-named milk formed, on an average, $\frac{1}{22}$nd of the total milk supplied to the dairy, and it differed from the ordinary milk not so much in quality as in mode of collection and distribution.

The "nursery-milk," indeed, was milk collected from three or four cows selected and set apart from the general herd for the purpose. It was sent to London in a separate "churn," and was issued to customers from the dairy only on special request made for it, and then it was distributed in "sealed" cans in the quantities required. Although designated, for convenience, "nursery-milk," this milk was not invariably used for nursery purposes. It was retailed at the same price as ordinary milk, and it was designed to meet the desire of those customers who had an objection to the mingled milk of many animals for nursery or other use. The quantity of "nursery-milk" supplied to the dairy night and morning, from day to day, for several months before, and at the time of the outbreak had not varied.

It has already been stated that suspicion first fell upon the "nursery-milk" as being, of the two different kinds of milk issued by the implicated dairy, that alone which was infected; but that it was presently observed that the ordinary milk could not be exempted from suspicion. Further investigation has tended to prove, not only that the first suspicion was correct, but that the ordinary milk was infected only to such extent as "nursery-milk" might have become mixed with it. An examination of the manner in which "nursery-milk" was distributed from the dairy at the period which concerns this inquiry, while confirming the suspicion which first attached to it, furnished the clue to an

explanation of the facts which apparently militate against the conclusion that the outbreak of fever was dependent upon the quality of the milk distributed from the dairy under consideration. The first step in the elucidation of the difficulties which appeared to beset this conclusion, was a study of the exemption from the outbreak of the 63 families living in Pimlico who received milk from the implicated dairy. It has been clearly ascertained, that during almost the entire period occupied by the inception and progress of the outbreak, the whole of the ordinary milk obtained from the farm from which the "nursery milk" also came, was distributed among these families. This fact excludes from suspicion of infection the ordinary milk coming from the farm in question. The exemption of these families removes also suspicion of infection of such other ordinary milk as may from time to time have been sent to them from the implicated dairy during the progress of the outbreak. But during the several weeks within which the outbreak was developed, ran its course, and came to an end, no "nursery-milk" whatever was sent from the implicated dairy to these families, and consequently they did not receive at any time any portion of the milk upon which suspicion first fell during the period of its presumed infection. No "nursery-milk," moreover, was distributed to the milk carriers, who were also exempted from the outbreak. These carriers had among them, for the use of themselves and families, as a rule, only such milk as they brought back from their several beats. This milk was first placed in one of the mixing-vessels of the dairy, and then divided among the different carriers. As "nursery-milk" was only issued from the dairy in the quantities required by separate families, each quantity in its own sealed can, no "nursery-milk" was ever brought back by a carrier. The only occasion when "nursery-milk" could find its way into the carrier's portion would be when the dairy superintendent might, if the portion were deficient, add a small quantity to it from surplus "nursery-milk" in the dairy; but this, it is stated, could have happened very rarely.

On the assumption that the "nursery-milk" was alone infected, the foregoing exemptions are readily explained. The same assumption, when regarded in the light of the facts now to be recorded respecting the distribution of the "nursery milk," furnishes an equally reasonable explanation of the other difficulties which have to be considered.

It has already been stated that the quantity of "nursery-milk" received at the implicated dairy did not vary from day to day. This quantity was calculated to meet the maximum requirements of the dairy, but these requirements only existed during a limited portion of the year when the general demand for milk was also at the greatest. When the pressure of business diminished, concurrently with the departure of customers from town at the close of the season, a surplus of "nursery-milk" remained undisposed of as such, and was dealt with in one or more of the several ways following:—It was either (*a*) "set" (as the phrase is) for cream; or (*b*) it was sent into the shop to be sold across the counter; or (*c*) it was used to supplement the general supply if it fell short. If "set" for cream, the skim milk would be sent to the Soho branch to be retailed there. If used to supplement the general supply, it was not mixed generally, or even to any considerable extent, with that supply. It was added to one of the last-served carrier's cans.

An examination of the books of the implicated dairy shows that the pressure of business in 1873, after fluctuating slightly during the weeks ending the 28th of June and 5th of July, steadily diminished during and after the week ending July 12th; nearly one-half the customers

who had left town prior to the last-named date being habitual consumers of nursery milk. From the 12th of July, and probably for several days previous, there would be a surplus of "nursery-milk," increasing in amount day by day as the pressure of business declined, to be dealt with in one or other, or all, of the ways just described. The Soho branch would then receive from time to time skim milk from the "nursery milk," and the customers of that branch be brought within the influence of the assumed infecting agency. From time to time also portions of "nursery milk" would find their way to the counter of the implicated dairy. We have related one case of infection presumably from milk drunk from the counter, and we refer to another believed to have been contracted in the same way. We believe, also, that several cases of enteric fever occurring in streets adjoining the implicated dairy, but not among regular customers of the dairy, are to be accounted for by the use of milk or cream purchased across the counter of the dairy at the time of the outbreak. Finally, the occasional supplementing of a deficient general supply by the "nursery milk" in the manner which has been described, would abundantly explain the infection of the general milk supply. From the limited extent, moreover, to which the general supply would be thus supplemented (never extending beyond an addition to a particular carrier's can at a given time), together with the fact that the "nursery milk" itself in its distribution did not find its way into the greater number of streets supplied by the implicated dairy, a clear explanation is forthcoming of the escape of many streets from the outbreak, and of the irregular distribution of cases within the area of the milk supply, as well as of the marked predominance of cases in some streets as compared with others.

The outburst of the fever among the households consuming ordinary milk occurred at the time when "nursery milk," as gathered from the books of the dairy, passed into the general distribution. This, as already stated, would happen in considerable quantity during the week ending the 12th July. On the second week following (ending 26th July), after the ordinary incubative period of the disease, the first attacks of enteric fever among households using ordinary milk, increased from an average of 5 per cent. in the three previous weeks to 86 per cent., that is to say, 17 times above that average. That this increased incidence upon households consuming ordinary milk was not owing to an augmented virulence of the infective agency, is to be inferred from the fact that among households consuming "nursery milk" the outburst of fever occurred a week earlier, namely, in the week ending 19th July, when the number of attacks of these households increased from 8 per cent. to 33 per cent.

5. From all the foregoing considerations, we have come to the ultimate conclusion that the probability of the outbreak of enteric fever under consideration having been caused by an infected milk supply, amounts for all practical purposes to a certainty. The results obtained in this respect from the detailed investigation have confirmed fully the opinions formed from the preliminary inquiry. We have now to state the results of the further investigation as to the probable source of infection of the milk. The action taken to this end, in conjunction with Dr. Whitmore, Dr. Corfield, the Medical Officer of Health for St. George's (Hanover Square), and Mr. J. Chalmers Morton, is related in the Appendix. Subsequent action was taken with the assistance of Dr. G. W. Child, the Medical Officer of Health for the Banbury (Oxon) Combined Sanitary District, in which district the farm described in the preliminary Report is situated, and with Mr. Hope, V.C., one of the

directors of the implicated dairy. The preliminary inquiry had made it certain that the milk of six out of the seven farms supplying the dairy was, at the time of the outbreak, free from any suspicion of infection with enteric fever material. But with regard to the milk from the seventh farm the result was very different. Here a condition of things was found which rendered it highly probable that milk from this farm had been charged with enteric fever material, and not improbably with the excremental discharges of a patient suffering from enteric fever, shortly before and during the earlier period of the outbreak in Marylebone. *From this farm was obtained all the milk specially supplied by the implicated dairy for nursery use, the consumption of which milk, as has already been shown, furnishes the strongest evidence of the infection of the milk.*

The farm in question is situated between the villages of Brill and Chilton, in Buckinghamshire, about a mile distant from each, and a foot-path connecting the two villages traverses the farm premises. The farm obtains its labour from both villages. Brill has a population of 1,353, and Chilton of 336, and from each village enteric fever is rarely long absent. During the 14 months ending the 31st August, 1873, there had been, according to Dr. Gent, of Brill (the dates not given), 14 indigenous cases of enteric fever in the village of Brill, occurring in six families, and two imported cases, one of them coming from Oxford, the other from London ; the latter being one of the cases of the outbreak in west London under consideration. During the months of June and July 1873 there were under the observation of Mr. M. H. Humphreys, of Thame, nine cases of enteric fever, occurring in five families, in the village of Chilton. One of these cases was attacked whilst working on the farm in question during the third week of haymaking, which began on the 21st June and lasted four weeks. The inquiry as to the relations of cases in the neighbouring villages and hamlets, and of the families in which cases occurred, with the farm was interrupted at this point.

On the 8th June the occupier of the farm died suddenly in the fourth week of an attack of ambulant enteric fever (*Typhus ambulatorius*). For some time previous to the seizure it had been suspected that he suffered from some disease of the heart. The suddenness of the death at a time when it was believed by his medical attendant that recovery from the enteric fever had commenced, led to the death being ascribed to the presumed heart disease, and to its having been certified as occasioned by this cause, no mention being made in the certificate of the disease from which he was considered to be recovering at the time of death.

The history of the case is as follows :—Illness had commenced on the 12th May; but although constantly ailing, the patient did not, in spite of the remonstrances of his medical attendant, Mr. M. H. Humphreys, of Thame, take to his bed until the 1st June. Mr. Humphreys quickly came to the conclusion that the anomalous symptoms from which his patient suffered most probably arose from "latent" enteric fever, a form of the affection frequently seen in the district where the farm is situated. This opinion was confirmed by Dr. Giles, of Oxford, on the 30th May, the patient, against the advice of Mr. Humphreys, insisting upon travelling to Oxford from Chilton, by way of Thame, a distance of about 20 miles. When seen by Dr. Giles, the characteristic eruption of the disease was present. On the second day following (the 1st June) the patient had profuse hæmorrhage from the bowels, which brought about a state of prostration that continued, notwithstanding the abatement of some of the graver symptoms, until the sudden death on the 8th June. The hæmorrhage persisted, with

diarrhœal evacuations, to a greater or less extent throughout the whole of the succeeding day (June 2), and a part of the day following that (June 3), when the bloody discharges ceased. Opium and mineral acids had been administered, and the bowels remained inactive from the 3rd to the 5th June, when a small dose of castor oil was given, which was followed by a natural stool. This resumption of the normal action of the bowels, together with the cessation of the hæmorrhage, induced a belief that the most dangerous period of the illness had passed, and that recovery had commenced; but the feebleness of the patient was still such that the attendants had been strictly enjoined not to raise him or to suffer him to attempt to raise himself to an erect posture. This injunction was disregarded by the patient on the 8th June, and death followed. The history of this case, indeed, is that of well-marked ambulant enteric fever.

Previous to the hæmorrhage there had been no disturbed action of the bowels. After the hæmorrhage Mr. Humphreys gave directions that all discharges from the bowels and bladder should be kept out of the common privy of the farmhouse, and buried somewhere outside the premises. This direction was carefully carried out; and from the first hœmorrhagic stool to the last chamber slops, all the discharges were removed to an ash-heap beyond the precincts of the farm buildings (as will presently be more fully described), and there the evacuations from the bowels were buried and the slops cast. No disinfectant was mixed with either the one or the other before being got rid of; for, on the one hand, it did not seem to be necessary from the place of burial or casting away; and, on the other, it was not advisable to retain upon the premises the great bulk of the evacuations, passed within a brief period, until a disinfectant had been procured.

On the 12th August a son of the above patient, aged 13 years, was seized with enteric fever, and he passed through a slight but well-marked attack.

Of other persons living at or engaged about the farm (11 in number), viz., the wife and daughter of the occupier, and nine daily labourers,* none had enteric fever at this time, neither had the families of such of the labourers as were married, so far as could be ascertained.

The farm premises, which it is necessary now to describe, and of which a plan and certain sections are attached (*see Plan and Sections*), are situated in a slight hollow in the bottom of a valley. The farmhouse and dairy are very old and incommodious, and a new and more commodious house and dairy, built upon a neighbouring hill, were about to be substituted for them. The farm premises generally are not more satisfactory, much of them ramshackle, and all in curious contrast with the care given to the milk when received into the dairy proper by the mistress of the farmhouse. The water for dairy purposes was obtained from a well in the yard adjoining the farmhouse (*see Plan*) which is mainly fed, by an underground conduit, from another well situated at some distance from the farm, to the west, in a meadow. There is but one privy on the premises, the position of which is shown in the plan. It is placed at a higher elevation than the well used for dairy purposes, and is 56 feet distant from its mouth. The drainage of the farm premises consists, first, of a surface drain for the house and churn-house, and an underground drain for the dairy, both of which run near to the dairy well, as we may term the last-named well (*see Plan*), and open into a ditch,

* These labourers used no milk from the farm except occasionally in their coffee, and then only if there were any surplus milk. They drank, moreover, no water from the dairy well, unless exceptionally, and then, as a rule, after it had been boiled, and in the form of coffee.

which carries off the drainage from them into a pond in the field below the farm; and, next, of a surface drain (a simple ditch) which runs from the farmyard and carries off so much of the drainage of the farmyard as may find its way into it to the ditch which receives the drainage from the first-named drains (*see Plan*). The farmyard drain runs across the line of conduit by which the dairy well is fed.

In this place it may be noted, as an incidental matter, that the live-stock of the farm at the time of the inquiry consisted of about 40 cattle, in excellent condition and health.

At the outset of the inquiry, there was reason to suspect that the dairy well might have become polluted with excremental matters. The position of the well was such, in the bottom of a shallow funnel as it were, that, notwithstanding the surrounding soil was a stiff clay, this had been so much broken up in different directions, as to render soakage either from the privy, the drains, or the pigsty not improbable. The water from the well had for some time been disused in the farm for drinking and cooking purposes, on account of a gradually increasing distastefulness, and for these purposes water was obtained from a spring on the hillside east of the farmhouse, at about a sixth of a mile or more distance. In the rare instances when the dairy well water, from the want of spring water at the moment, may have been lately used, it has probably been without exception for the making of tea or coffee. The increasing distastefulness of the dairy well water, which had led to its disuse for other than dairy purposes, arose certainly from two, and probably from three sources. First, the well in the meadow from which the dairy-well water was mainly fed, was polluted by the stalings and dung of cattle. This well is 11 feet deep by 5 feet in diameter, and is steined with rough unmortared stones. Over the mouth a few loose planks are placed, and wooden rails fence it off from the field. Around these rails the ground is much broken up by the treading of cattle, which appear to court the vicinity of the well when turned to graze in the field. Other more offensive evidences of their partiality for the vicinity of the well are to be observed, and no doubt explain the results of chemical analysis as given below.* Next, where the conduit from

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* "*Report on a sample of water received September* 4, 1873.—Water contained in two Winchester quarts; stoppers tied over; each bottle labelled 'Chilton Grove Farm Well, in the Home Ground, August 30, 1873.'

"The water is slightly turbid, of yellowish-brown colour, and slightly musty odour. It is rather hard, but becomes tolerably soft on boiling. It holds an excessive amount of salts in solution, the greater part of which consist of the sulphates and chlorides of sodium and potassium. The amount of nitric acid present is not great, but there is an excessive amount of ammonia, and the proportion of nitrogenized organic matter present is also rather high, both indicating considerable contamination by sewage or surface drainage. The large amount of chlorine, the very strong trace of phosphoric acid, and the quantity of oxygen absorbed from permanganate, point also strongly in the same direction.

"The analytical details are given in the Table annexed:—

"Appearance		Turbid.
Colour		Yellowish-brown.
Smell		Musty.
Deposit		Slight.
Nitrous acid		Very minute trace.
Phosphoric acid		Very strong trace.
Hardness, before boiling		22 degrees.
„ after boiling		4·6 „
Oxygen absorbed from permanganate		0·1008 grains per gallon.
Total dry residue		114·38 „
Consisting of	Volatile matters	10·36 „
	Fixed salts	104·02 „

this well to the dairy well passes by the entrance to the farmyard, in which part of its course it lies nearest the surface, the ground is much broken up by the treading of the cattle coming out of and passing into the yard. The ground here is apt to crack deeply in dry weather, and it is not improbable that at such times, if not at all times, farmyard drainage may find its way into the dairy well. The third source of pollution, which touches immediately the subject of the present report, was discovered by Mr. Hope.

A series of carefully executed excavations were carried out under the supervision of Mr. Hope, one of ourselves and the manager of the implicated dairy being also present, to determine whether soakage from the privy and from the drains of the farmhouse could find its way into the dairy well. A previous examination of the interior of the well, the water having been pumped out for the purpose as low as practicable, disclosed a well-marked line of soakage through the interstices of the brick steining on the south side of the well, 3 feet 6 inches above the inlet of the drain from the feeding well, and 9 feet from the surface. Other more doubtful points of soakage existed, which need not be described.

The position of the trenches dug in the excavations made are shown by dotted lines on the Plan. These excavations proved conclusively, (1) that no soakage was possible from the privy into the dairy well; (2) that no soakage had taken place either from the surface yard

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Chlorine	5·46 grains per gallon.
Nitric acid ($N_2 O_5$)	0·68 „
Nitrogen in ammonia	0·073 „
Organic nitrogen	0·025 „

" (Signed) A. Dupré.

" Westminster Hospital, September 9, 1873."

A copy of analysis of water from the " Dairy Well " is subjoined.

" *Report on a sample of water received August* 14, 1873.—Sample contained in two Winchester quarts; stoppers tied over; each bottle labelled, 13th August, 1873. Pump, Chilton Grove, used for cleansing milk cans and for dairy purposes.

" N.B. Well-mouth opened half an hour before specimen taken, and a portion of earth and mortar fell in.

" The water is turbid, of yellowish-brown colour and without odour. It is extremely hard, and holds an excessive amount of salts in solution, consisting in great part of the chlorides and sulphates of sodium and potassium. There is not much nitric acid, but ammonia and nitrogenized organic matter are present in rather high proportion. A considerable amount of chlorine is also present, and much oxygen is absorbed from permanganate. In fact, the water shows all the characteristics of recent contamination by sewage or surface drainage.

" The analytical details are given in the Table annexed:—

" Appearance		Turbid.
Colour		Yellowish-brown.
Smell		Inodorous.
Deposit		Slight.
Nitrous acid		None.
Phosphoric acid		Very strong trace.
Hardness, before boiling		36 degrees.
„ after boiling		17 „
Oxygen absorbed from permanganate		0·112 grains per gallon.
Total dry residue		121·66 „
Consisting of	Volatile matters	11·48 „
	Fixed salts	110·18 „
Chlorine		7·315 „
Nitric acid ($N_2 O_5$)		0·370 „
Nitrogen in ammonia		0·0147 „
Organic nitrogen		0·0273 „

" (Signed) A. Dupré.

" Westminster Hospital, August 18, 1873."

drain or from the dairy drain into the well ; and (3) that no soakage from the farmyard drain, or the farmyard, or elsewhere had passed along the upper part of the trench in which the conduit from the well in the meadow to the dairy well was laid. These questions having been successfully put aside, a trench was run up to the yard wall, from the garden plot on the south side, a little to the east of the position of the well, and on digging beneath the foundation of this wall unquestionable signs of soakage of some foul matter were found. On this being discovered, an excavation was made between the well and the yard wall, and a line of soakage disclosed along the foundation of the wall, through the made earth intervening between the wall and the well, to the point where soakage had been discovered in the well.

The reason of the growing foulness of the water from this well, which had caused its disuse some time before for drinking and cooking, now became at once obvious. The soakage could only come from one direction, that of the pigsty. The yard wall and the southern wall of the pigsty and their foundations were continuous. The drainage of the pigsty flowed to the south side of the wall, and there accumulated. (*See* Plan.) The surface drainage from the yard was also occasionally dammed up against the wall, as one of us at the time of the first inspection of the premises had occasion to see. Now there can be no reasonable doubt, from the result of the excavations, that the drainage of the pigsties and of the yard had, in the progress of time, made its way along the foundation of the wall, a distance of about 25 feet, to the vicinity of the well, and then soaked through the intervening soil into the well. The latter process, from the nature of the soil, would be a slow one, but it had been accomplished so effectually that the clay which constituted the bulk of the made ground between the wall and the well, was, along the line of soakage, reduced to the consistence of very soft paste.

Against the wall along the foundation of which this soakage takes place, and close to the pool formed by the drainage from the pigsty, is the ash heap of the farm. In this ash heap were buried all the evacuations from the bowels of the sick occupier of the farm on the 1st, 2nd, and 3rd of June, and upon it were cast all the chamber slops of the sick man's room from the 1st to the 8th June. *In other words, by an unhappy and altogether unforeseen chance, and in carrying out precautions to obviate any possibility of mischief the matters from which mischief was most apt to arise were deposited in perhaps the only spot on the farm premises where they would certainly find their way into the water used for dairy purposes.*

There is probably no etiological truth more clearly established than that of the propagation of enteric fever by water contaminated by the discharges of persons ill of the disease. The next step of the inquiry was then directed to ascertain whether such ordinary use was made of the dairy well water as would probably lead to its being mingled with the milk in proportion sufficient to cause the outbreak. It will be observed how completely such an assumption would meet the known phenomena of the disease and of the outbreak. The outbreak began in the week ending July 5, that is to say, during the last days of June and the first days of July; consequently, the cause determining the outbreak must have begun to operate sometime during the week ending the 21st June. The dropping cases of the first three weeks of the outbreak were followed by the great outburst extending over three weeks and then by a decline, sudden at first, but occupying three weeks

following. These phenomena might not unreasonably be held to have reference to the physical phenomena of soakage of the infective matters into the well, slowly and in small quantities at first, rapidly increasing in amount as the infective matters occupied more fully the line of soakage, and as rapidly declining, but still not at once, and wholly coming to an end, as those matters became exhausted. Given a fortnight for the soakage to begin to affect the water, a not undue period having regard to the kind of soil it would have to pass through in a part of its course, the rest of the phenomena would consistently explain the outbreak provided the contaminated water were mingled with the milk. It is not unimportant to observe, in respect to this soakage, that it would take place under conditions reducing the destructive changes among the infective matters which otherwise might have been facilitated by the soil to a minimum, for the whole line of soakage was previously sodden with moisture, a condition which largely deprives earth of its peculiar action upon excremental matters.*

For practical purposes, and apart from all theoretical considerations, it was sufficient to know that the only water used for all dairy purposes upon the farm was a water liable to be contaminated, and which was at a particular period, in all probability actually contaminated, in the exceptional mode described. This water was, for the purpose of cleansing the dairy utensils, as a rule used cold, and simply as taken from the well. In cleansing the churns, for example, these were rinsed with the water before each time of use, and then wiped inside and out with cloths. The necessary frequent scalding of the churns with boiling water was not, except at long intervals, carried out at the farm, but at the dairy in London to which they were consigned. Of any actual mingling of the well-water with the milk, other than might arise from imperfect drying or draining of the interiors of the churns after rinsing, no evidence was obtained, nor, indeed, can be expected at any time, in such inquiries, except by accident. But no accidental pollution would explain the limitation of the infection to "nursery-milk," or the persistence of this infection for a definite time.

6. The conclusions, however, as to the infection of the milk, and of the probable connexion of the infection with this particular farm, rest upon evidence entirely apart from that which relates to the mode of infection of the milk. It must be remembered that the failure to show in what manner this infection may have happened, does not in the least militate against the evidence of infection. This latter evidence, as well as that relating to the source of infection on a particular farm, can be dealt with separately from the question of the mode in which the infection may have come about. It is necessary to insist upon this point, because there is a tendency to make the two former questions depend upon the solution of the latter. Now, although it is most

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* We have been favoured by the Rev. Robert Main, M.A., F.R.S., of the Radcliffe Observatory, Oxford, with a Table (*see* Appendix, Table II.) showing the mean daily readings of the barometer and thermometer, and the amount of rainfall, day by day, at the Radcliffe Observatory, during the months of June and July 1873. Chilton Grove Farm is situated 10 miles, in a direct line, from Oxford, in a valley among the hills on the Buckinghamshire border. The states of temperature, and perhaps even of rainfall, at Oxford will probably in their general features indicate pretty closely the states at Chilton Grove Farm. The high, and on some days excessive temperature shown by the Table to have existed with little interruption from the 16th to the 29th June, is suggestive in connexion with the starting activity of infection from the farm. The heavy rainfall on the 29th June (probably more prolonged among the hills) is also suggestive, as such rainfall would facilitate a more rapid passage of infective matters into the dairy well.

desirable that the method of infection should in all cases be, if possible, determined, the question is one presenting difficulties for solution which, as a rule, will probably prove insuperable. For not only do these difficulties beset the inquiry as to the ordinary intimate habits of a farm, but they are always complicated with the possibility of the milk having been tampered with without any knowledge of the farmer, and within such limits as to render the methods of testing usually employed in dairies quite unavailable for detection.

For the ultimate purpose of this inquiry, it is sufficient to have shown a probability amounting, for practical purposes, to a certainty that—

(1.) The outbreak of enteric fever which forms the subject of inquiry, was caused by milk infected with enteric fever material;

(2.) That this milk came from a particular farm;

(3.) That the water used for dairy purposes on this farm contained excremental matters from a patient suffering from enteric fever immediately before and at the time of the outbreak.

Preventive action, to be of any value, must follow upon the reasonable probabilities of a case such as this outbreak, and not wait upon a minute etiological elaboration. The course to be taken, and which was followed, was clearly obvious at the time of the preliminary inquiry, and the justness of that course is, we think, confirmed by the detailed investigation. The implicated dairy at once stopped the supply of milk from the farm; and the mistress of the farm (the widow of the late occupier), although acting against her own convictions, with a decision which did her infinite credit, immediately stopped all issue of milk from her farm, and gave up the use of the dairy-well. Dr. Whitmore first received information of the outbreak, and of its probable cause, on the 4th of August. On the 8th he had become aware that the event involved issues which extended beyond his own district, and he took those measures which made it possible to push the preliminary inquiry quickly to its end, and to stop the supply of suspected milk on the 12th.

It will rarely happen that the source of an outbreak of the kind under consideration will be so readily traced and rapidly followed out as in the present instance. But, notwithstanding the quickness of detection, and the ready action taken upon it, the detailed inquiry, of which the results are given here, we think, tends to prove *that the infection of the milk had probably ceased before the discovery of the source of the outbreak*, that is to say, before the 4th of August.* No evidence has come to our knowledge of any case certainly connected with the milk after the 12th August. It would follow, therefore, that, if any effective action is to be taken for the prevention of outbreaks of enteric fever from infected milk, this action must be directed to the removal of possible sources of infection. In the present instance, and in other instances, the milk probably became infected from the water used for dairy purposes having been previously infected. Some instances are on record in which it would seem probable that the milk had become infected by being placed in such relations with the sick, or

* One case was reported to us in which milk was stated to have been drunk, once and once only, at the dairy on the 8th or 9th of August, and in which the individual sickened of enteric fever at a period variously stated from three to six days afterwards. As it was impossible to exclude other probable sources of infection in this case, we have not included it in the series connected with the milk supply.

the sick chamber, as to absorb, or in some other way become contaminated with the enteric fever material. In both kinds of instances the question of prevention becomes a part of a more general question touching the regulation of dairy farms.

7. And first, in respect to the water supply of these farms, the probable medium of infection of the milk in the outbreak under consideration. The water supply of several of the dairy farms which came under observation in the course of the inquiry, not only the farms supplying the implicated dairy in the metropolis, but also others, was either exceedingly impure, or was exposed to chances of contamination similar in kind to that described in this Report. The following examples may be given in illustration :—

A considerable and otherwise excellently-ordered dairy-farm : the well of the farm, partly supplied by percolation, but chiefly by collection of surface water, which passes from a large pond into the well along a deep trench arranged as a filter. Thirteen feet from this trench, and 30 feet from the mouth of the well, is a capacious privy-pit, lined with brickwork and cemented. This privy-pit is emptied only at long intervals. Soakage from the privy-pit into the well is held to be impossible ; first on account of the construction of the pit, and next, on account of the soil intervening between the privy-pit, and the well being clay. There is no assurance that these reasons are valid, because cemented brickwork is not a sure safeguard against soakage of excremental matter, and it is not certain that the soil lying between the privy-pit and the well has not been disturbed. The surface water also is apt to be polluted from manure spread on the land, from which it is obtained. In addition to the chance of excremental pollution of the well from these sources, a pond, from which an occasional supply of water is obtained, is exposed to excremental pollution, a privy-pit being built on the edge of it. An examination of the water from this well, made on the 29th August, showed that it had then a most unpleasant odour, and an analysis of a specimen collected that day gave results which could leave no doubt that it was laden with excremental matters, brute or human, or both.* Water of the degree of impurity indicated by the analysis given below is certainly not fitted for dairy purposes any more than for household purposes. If, as we believe

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* " *Report on a sample of water received September* 4, 1873, and collected August 29, 1873 :—

" The water is very turbid, has an offensive smell, and contains much ammonia and nitrogenized organic matters. It is a very bad water.

" Appearance		Very turbid.
Colour		Brownish-yellow.
Smell		Slightly putrid.
Deposit		Much brown, flocculent.
Nitrous acid		None.
Phosphoric acid		Much.
Hardness, total		22 degrees.
„ after boiling		5·5 „
Oxygen absorbed from permanganate		0·314 grains per gallon.
Total dry residue		46·48 „
Consisting of { Volatile matters		6·38 „
Consisting of { Fixed salts		40·10 „
Chlorine		5·81 „
Nitric acid (N_2O_5)		0·11 „
Nitrogen in ammonia		0·045 „
Organic Nitrogen		0·063 „

" (Signed) A. Dupré.

" Westminster Hospital, September 17, 1873."

probable, the excremental pollution partly arises from soakage from the privy-pit, the water in the well may at any moment become infected, either as a direct consequence of that pollution, under conditions as yet undetermined, or from the discharges of a person suffering from enteric fever finding their way into the privy-pit, and thence into the well. Should this happen, there is no surety that the milk would not be infected through the water, and become the medium of an outbreak of enteric fever of much greater magnitude than the one described in this report.

The imminence of this kind of danger was strikingly illustrated during the inquiry by an example brought under observation by Dr. Child, the Medical Officer of Health for the district, and which formed the subject of a conjoint inspection. The occupier of a large dairy farm had died, after a few hours' illness, with severe choleraic symptoms. All the earlier copious alvine evacuations of the patient had been passed into the privy of the farmhouse. This privy was situated 30 feet from the mouth of the well which supplies the house and dairy with water. Both the privy-pit and the well are hollowed out of an outlier of pervious and fissured corn-brash, upon which the farmhouse and neighbouring village are built. The privy-pit is emptied at yearly or longer intervals, more frequent cleansing not being necessary from the facility with which the liquid contents pass away into the soil. At the time when the occupier was first seized with his fatal illness there was a momentary doubt whether the disease was not Asiatic cholera, for the seizure happened at a time when that disease was spreading on the Continent, and scattered cases had been introduced into England. If the attack had proved to have been one of Asiatic cholera, it is not pleasant to contemplate the consequences which might have taken place had the discharges found their way, as they probably did do, into the well. It is hardly more agreeable to contemplate the possible consequences of ordinary choleraic discharges obtaining access to water used for dairy purposes. The chances of mischief arising from this dairy farm at this time were perhaps diminished by the milk being mainly used for butter making.

In the same dairy farm was also observed the extraordinary arrangement of the washhouse communicating with the dairy. At the time of inspection the washing of house-linen was in progress, and upon one of the slabs in the dairy was piled up a quantity of rough-dried linen, body and other. It is impossible to set a limit to the chances of infection under arrangements of this kind, if a contagious disease should be present in the house.

The foregoing examples are taken from first-class dairy farms, and no good will arise from multiplying illustrations from lower grade farms, where like conditions exist in a greater or less degree. Two examples may be given, however, illustrating from another point of view the curious indifference which exists among farmers to the quality of the water-supply used for dairy purposes.

The first instance refers to a very old farmhouse, the water-supply of which is obtained from a running stream. A conduit from this stream brings the water for domestic and dairy purposes to a catch-pit, and is separated from the cattle yard by a simple brick walling and a thin layer of soil. The yard is deep in the accumulated bestial filth of years, and the soil and adjacent wall-foundations are super-saturated with the soakage from the filth above. A simple inspection of the catch-pit shows that it must be within the limits of soakage. Lower down the stream from which the conduit supplying this catch-pit takes its depar-

ture, the current is dammed, and here is arranged the cooling place for the freshly-filled milk churns. Suspended from a branch of an overhanging tree, the churns rest in the bright, flowing stream. The arrangement for its efficiency might well excite the envy of less-favoured dairy farmers. And, indeed, when seen in a glowing sunset, the arrangement formed the centre of a bit of rustic scenery delightful to the eye, for the stream at this spot was overshadowed by abundant foliage. But amidst this foliage, a few yards above the suspended churn, up stream, was discovered, fixed across the running water, the common privy of the farmhouse !

Again, a spring was visited from which it was contemplated, in the event of a sufficiency of water not being found by sinking a well on the premises, to supply a new and handsome farmhouse and dairy. This spring flows from a hill-side beneath a clump of hawthorns, and forms a picture which would please an artist, if he had the courage to get at it. The water is conducted first into a trough for the use of cattle, and the overflow passes in two directions. In the one it is led to a roughly made reservoir, in the other to a small trough for the use of a cottage, and the overflow from this latter trough passes still lower down the hill-side to another cattle-trough. So ill tended are all these arrangements, that on the slope above the spring, and around the two cattle-troughs, the ground is trodden into almost impassable sloughs by the cattle, and the water, even from the outlet of the spring, is indescribably fouled by their stalings and dung. The water in the cottage trough had a distinct brown colour, and the water in the lower cattle-trough was, in addition to the fouling at its source, exposed also to pollution from the drainage of a pigsty placed on the bank above. *Water from the uppermost trough—from the springhead, in fact—in the state in which one of us saw it had been used for dairy purposes.*

Until this habitude of using, and indifference to the use of, foul water, or of water liable to be fouled, for dairy purposes is put a check to, probably the most important source of infection of milk with enteric fever material will hardly be removed. Such infection is, indeed, to be held as one of several highly probable evils arising from this source. One of the results of this inquiry which has been most forcibly impressed upon the reporters is that the use of water for dairy purposes fouled after fashions such as have been described may, by inducing changes in the milk, particularly under high ranges of temperature, play an influential part in determining fatal infantile diarrhœa.

Aided by the growing feeling among farmers themselves of the indecency and impropriety of using impure water for dairy purposes, it ought not to be very difficult to put a stop to the evils of the kind discussed in this Report. The main obstacles, perhaps, in the way of improvement hitherto have been mistaken estimates of the mischief arising from these evils, and of the cost involved in carrying out the necessary changes to remove them.

If the descriptions given in this Report have not failed of their object, a brief consideration of them should show that the alterations required in the different farms to abate or prevent the pollution of their water-supply are of the simplest and least expensive kind. Take the farm in which the subject of the present inquiry has been centred, the work would be both easy and little costly to make the feeding-well in the meadow free from all chance of pollution from the surface washings and soakage. Means as simple and little costly could be devised to carry this water to the farmhouse, and there store it beyond the practicability of pollution except from wilfulness or carelessness. In the

second farm described, where the question of water-supply is one of no little difficulty, the removal of the privy-pit and of the earth intermediate between it and the well, substituting fresh earth, also the removal of the privy-pit from the edge of the pond which furnishes an occasional supply, would obviate probably the only serious danger to the water-supply. Such impurity as finds its way into the collected surface water ordinarily used should be dealt with by a more effectual filtration. In a neighbouring farm, where the occupier had some reason to suspect that the well might be affected by the privy-pit, this had been filled up and the danger entirely removed by the adoption of a pail-closet. In the third farm described, the filling-up of the privy-pit, the adoption of a pail-closet, and, in addition, the removal of a piggery, placed too near the well, to another part of the farm, would save the well. Of the other instances given, the proper manner of dealing with them, and the simplicity of the requirements, must be obvious. No instance has been observed during this inquiry in which possible or actual pollution of the water-supply has not arisen from the failure to observe common sense rules in the arrangements for collecting the water, for excrement disposal, or for drainage, and in which the evil results thus arising could not readily be remedied.

It is not probable, however, that the improvements indicated above, in the regulation of dairy farms, will be carried out either so quickly or so completely as is to be desired in the interest of milk consumers, if they are left to the sole action of farmers and milk dealers. The proprietors of the implicated dairy had not been unmindful of the sanitary condition of the farms from which they obtained their supply, and they had endeavoured to secure the rectification of such evils as might affect the purity of the milk. But their efforts were practically futile, except in so far as they referred to the manipulation of the milk and the condition of its delivery. This, we apprehend, must be the customary result as regards the matters immediately under consideration until the Local Sanitary Authorities interfere. We believe such interference to be necessary for the proper regulation of dairy farms, and to this end the Sanitary Authority should be possessed of a thorough knowledge (obtained through its medical officer of health) of the dairy farms within its district, in respect of the different matters referred to. The powers of inspection which a sanitary authority now possesses, and its ability to deal with certain defects of privies and drainage would, judiciously exercised, meet some of the evils described; but, having regard to the very serious dangers to which milk consumers are exposed from them, it would appear to be desirable that any further powers which may be requisite for carrying out such inspections successfully should be granted, and that the authorities should possess the power of closing polluted sources of water supply in case of necessity.

The proprietors of the dairy through which the infected milk was distributed in London, during the outbreak which forms the subject of this Report, have, since the outbreak, adopted, in addition to previous precautions, an elaborate system of inspection, medical and veterinary, on the farms supplying their dairy, and are again endeavouring to bring about upon them all necessary sanitary improvements. It is most improbable, however, that such private measures will become general, or, if general, successful; and already it has been discovered that in some dairy farms much-needed improvements in the interest of milk consumers will not be carried out unless the law interferes.

APPENDIX.

Mr. J. Netten Radcliffe's Preliminary Report on the present prevalence of Enteric Fever in Marylebone and adjoining Metropolitan Districts.

In accordance with instructions received on the evening of Friday the 8th instant, I proceeded at once to make an investigation of the facts communicated to the Department respecting the prevalence of typhoid in Marylebone, and the reported connexion of this prevalence with the distribution of milk from a particular dairy; and having satisfied myself that there were sufficient grounds for suspecting that the disease might have been disseminated through the medium of milk, early the next morning I placed myself in communication with Dr. Whitmore, the Medical Officer of Health for Marylebone, and at 10 a.m., in company with him, I had an interview with the directors of the suspected dairy. Dr. Whitmore had already been in communication with the directors on the subject, and they had sought the advice of Professor Corfield. The last-named gentleman was present at the meeting, and I had the advantage of his co-operation, as well as that of Dr. Whitmore, in the subsequent proceedings. The directors, without reserve, offered every facility for pursuing the investigation with which I was charged, and although unconvinced by the evidence which had to that time been laid before them as to a probable relationship between the prevalence of typhoid in Marylebone and the distribution of milk from their dairy, they immediately assented to the suggestion made by Dr. Whitmore and myself, and supported by Dr. Corfield, that the different farms from which they obtained their supplies should be inspected.

This inspection could not be carried out earlier than the Monday following; and in the course of Saturday and Sunday I was able to obtain information relating to numerous cases of enteric fever which had occurred in 28 households living in Wimpole Street, Queen Anne Street, Mansfield Street, Nottingham Place, Green Street, South Audley Street, Portman Square, Seymour Street, and St. John's Wood. This information made it probable that the cause of the coutbreak of enteric fever in the streets in question was the distribution of milk contaminated with the poison of the disease. Reserving details for a later report, it is sufficient for my purpose here to state that—

(*a.*) The cases had almost all occurred in the month of July, and the greater number of them in the course of a single week.

(*b.*) I had the assurance from the Medical Officer of Health for the Marylebone district, Dr. Whitmore, that the sewerage of the localities in his district, where enteric fever was most prevalent, was in thorough order, that it had long been so, and that the distribution of the fever was not according to any particular line of sewers.

(*c.*) The cases were distributed in the area of two several water companies, in a manner that appeared to negative the supposition that the general water supply could be at fault, or that there could have been contamination of a particular local branch of supply.

(*d.*) In the cases which had been most completely observed, the chances that the disease had been contracted outside the patient's house, or that it in any way depended upon sanitary defects of the house, could be almost absolutely excluded.

(*e.*) The above circumstances being taken into account, and the various known means of fever-dissemination being reviewed, the way that suggested itself as being here the most probable was distribution of the material of the disease with some article of food.

(*f.*) There were several important facts which seemed to point directly to milk as this sourse of dissemination :—

(1.) Of the 28 households, 26 obtained their supply of milk from the same dairy.

(2.) The number of children affected was proportionately very great.

(3.) In the instance of adults affected, large use of milk was a notable fact.

(4.) In the infected streets the disease picked out as it were the houses supplied from the particular dairy.

(5.) In particular families, in more than one instance, the disease picked out the members who drank the suspected milk, and those only.*

The results of this preliminary investigation made it imperative that the farms from which the suspected dairy derived its milk should be inspected without delay, and on Monday, accompanied by Dr. Whitmore, Dr. Corfield, and also by Mr. J. Chalmers Morton, who had been requested by the directors of the suspected dairy to assist in the inquiry, I proceeded to Oxford for the purpose.

A list of all the farms from which the suspected dairy had been recently supplied with milk was prepared for me. An examination, which I had made on Sunday morning, of the mode of dealing with and distributing the milk from the suspected dairy in London, satisfied me that the implication of a single farm would go far to explain, if it did not wholly explain, the phenomena of the outbreak in London. The farms were seven in number, two of them being situated near Oxford, the remainder in the vicinity of Thame. An examination of the reports of the Registrar General for the first and second quarters of the year showed that three of the farms were situated in a sub-district which must have been the scene of a serious outbreak of enteric fever extending over the two quarters.

The whole of the farms were carefully inspected by me and the gentlemen associated with me in the course of Tuesday and Wednesday, but before the close of Tuesday the evidence became so strong that at a particular farm there had been opportunities of fever infection, that it was decided to telegraph to the dairy in London to suspend immediately the issue of milk from this farm, and Dr. Corfield telegraphed to this effect. I have since my return to town ascertained that this telegram was acted upon, and that from that time the issue of milk from the farm in question ceased. I may add that all supplies from this farm are now stopped.

On Wednesday morning, before which period we were not able to visit the suspected farm, we made a detailed inspection thereat, by which the course taken the night before was fully justified. Of all the farms inspected, in this alone had we found any reason to believe that milk contaminated with enteric fever poison might have been issued during the period over which the inquiry extended. In the farm now under consideration we found the following state of things:—

(*a.*) The water supply of the farm used for dairy purposes was manifestly polluted—so manifestly as to prevent its being used ordinarily for drinking purposes in the farmhouse—and there was good reason to believe that this pollution might be in part excremental.

(*b.*) The proprietor of the farm had, a few weeks before the outbreak, been the subject of enteric fever, from which he was recovering, when, on the 8th June, he died suddenly of heart disease.

(*c.*) The labourers working on the farm, nine in number, came from the villages of Brill and Chilton, both villages much infected for some time with enteric fever, although it was not known that any of the labourers had themselves suffered from the disease.

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* In the subsequent investigation the instances to which this statement referred proved to be cases in which members of the family had been accustomed to take the milk largely in its natural state, as compared with other members who only used it with coffee or tea.—J. N. R.

(*d.*) The mode of carrying on the dairy work was such that, given the infection of enteric fever on the premises, more than one mode could be suggested in which the poison of the disease might be conveyed into the milk.

(*e.*) The time of the farmer's illness from enteric fever was, in conjunction with the state of things found on the farm, quite reconcilable with its being the source of the outbreak of enteric fever in Marylebone, &c.

A review of the whole circumstances of the inspection led me to the conclusion that the outbreak of enteric fever in Marylebone and neighbouring districts, which was the subject of my inquiry, had most probably its origin in the distribution from this farm of milk contaminated with the poison of this disease.

I have the gratification of stating, that on this conclusion being notified to the manager of the farm—the widow of the lately deceased farmer—she, notwithstanding the difficulty she felt in admitting its correctness, at once said that she would stop the issue of milk, upon her own responsibility, for the time being.

I have now reported, briefly, the action I have taken in this investigation to the present time. In continuing it, it will be necessary on the one hand to make a complete inquiry into the facts of the outbreak in Marylebone and the neighbouring metropolitan districts, and on the other hand to carefully examine the state of things in respect to enteric fever, which had come under observation in the inspected district about Thame, as well as to inquire into the prevalence of fever in the sub-registration district of Brill, and the possible infection of other farmsteads there. In several of the farms inspected, the possibility of pollution of the milk with enteric fever poison, if enteric fever should show itself in the farm house, or among the labourers working upon it, was obvious, and it seems to me that an inquiry directed to the removal of this danger, may, now that the sanitary organisation of the rural districts is a definite matter, be carried out with some prospect of success.

I propose, therefore, subject to the approval of the medical officer,—

1. To make a detailed investigation of the outbreak of enteric fever in Marylebone and neighbouring districts, for which, having regard to the time which will otherwise be occupied in this inquiry, I must ask for some assistance.*

2. To inspect carefully the Brill sub-registration district and the district about Thame, with special reference to the subject of the prevention of such outbreaks of enteric fever as that which forms the subject of this investigation.

Medical Department of the Local Government Board,
August 15, 1873.

Postscript.—I visited the suspected farm a second time on the 19th instant, when I was accompanied by Dr. G. W. Child, the Medical Officer of Health for the district. We found that no milk had been sent from the farm since the date of my first visit; that the water from the polluted well, previously used for dairy purposes, had been entirely disused, and the pump by which it was obtained, deprived of its piston; that the dairy had also been disused, and that arrangements were almost completed for carrying out the dairy work in future in new buildings at the top of a neighbouring hill, the water for dairy purposes being obtained from a spring at some distance from the house, believed to be quite free from danger of sewage contamination. From the medical attendant at the farm, whom we met there, we learnt that a son of the occupier, who had been indisposed at the time of my first visit, was suffering from well marked enteric fever.

J. N. R.

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* Mr. W. H. Power was, by direction of the Board, associated with me from the date of this Report, in the inquiry.—J. N. R.

Table I.—Showing the Weekly Mortality from "Fever" and Diarrhœa in the Metropolis, 1873.

Week.	"Fever."		Diarrhœa.		1873. Means (Greenwich.)*		
	Average Mortality 10 Years, 1863–72.	Mortality, 1873.	Average Mortality, 10 Years, 1863–72.	Mortality, 1873.	Barometer.	Temperature.	Rainfall.
							Inches.
1	53·9	25 −	13·8	15 +	29·58	45·2 +	0·80
2	56·1	22 −	13·5	13 −	29·69	47·9 +	0·92
3	55·0	22 −	13·5	11 −	29·81	46·1 +	0·26
4	50·4	25 −	12·0	13 +	28·98	37·4 =	0·62
5	54·8	25 −	14·5	13 −	29·86	33·3 −	0·02
6	48·8	24 −	13·3	23 +	29·75	32·9 −	0·59
7	52·3	27 −	14·3	12 −	30·07	36·0 −	0·04
8	49·6	37 −	13·1	18 +	30·32	33·4 −	0·08
9	47·9	19 −	13·8	13 −	29·33	36·0 −	1·44
10	47·0	18 −	13·3	10 −	29·58	43·3 −	0·24
11	47·4	24 −	12·2	25 +	29·38	38·6 −	0·40
12	45·6	35 −	11·6	25 +	29·72	39·1 −	0·31
13	46·6	34 −	14·0	10 −	29·86	45·3 +	0·01
14	43·0	20 −	12·8	18 +	29·83	48·6 +	0·21
15	46·1	25 −	14·2	20 +	29·85	41·7 −	0·19
16	46·8	29 −	15·7	15 −	29·59	52·1 +	0·06
17	47·8	19 −	14·2	10 −	29·89	42·5 −	0·07
18	40·9	20 −	14·0	13 −	29·84	48·5 −	0·27
19	41·7	25 −	14·9	13 −	29·55	48·4 −	0·90
20	39·5	34 −	16·6	12 −	29·87	50·1 −	0·15
21	39·0	22 −	14·5	12 −	29·80	49·6 −	0·27
22	41·0	22 −	20·5	16 −	29·96	53·4 −	0·17
23	38·8	22 −	24·7	17 −	29·80	55·4 −	0·68
24	40·9	24 −	23·5	18 −	29·62	56·8 −	0·26
25	40·2	16 −	55·8	20 −	29·89	60·4 +	0·67
26	39·1	20 −	86·7	22 −	29·89	60·2 +	0·00
27	41·3	24 −	125·9	68 −	29·71	61·6 +	0·98
28	44·4	20 −	159·3	100 −	29·79	62·6 +	0·49
29	43·3	21 —	231·0	205 −	29·73	59·1 −	1·21
30	41·9	37 −	310·5	305 −	29·86	68·8 +	0·03
31	42·9	22 −	313·7	375 +	29·86	63·7 +	0·27
32	41·8	25 −	273·5	470 +	29·84	66·0 +	0.45
33	44·4	30 −	239·9	405 +	29·85	63·5 +	0·55
34	44·7	32 −	213·9	362 +	29·68	60·0 −	0·65
35	45·8	38 −	181·6	277 +	29·63	61·9 +	1·20
36	47·2	27 −	158·9	229 +	29·76	56·0 −	0·51
37	49·8	26 −	127·0	162 +	29·62	55·0 −	1·10
38	47·3	34 −	90·5	127 +	29·61	55·0 −	0·97
39	47·6	39 −	80·1	85 +	30·10	54·4 −	0·00
40	42·7	43 =	59·0	71 +	29·84	57·2 +	0·00
41	48·4	45 −	47·5	43 −	29·67	52·0 =	0·52
42	48·0	32 −	41·2	30 −	29·74	48·4 −	1·29
43	49·0	55 +	31·1	29 −	29·38	44·8 −	0·71
44	53·8	42 −	25·1	21 −	29·78	38·9 −	0·32
45	50·0	35 −	21·5	18 −	29·36	44·9 −	1·46
46	53·5	47 −	19·9	13 −	29·92	40·8 −	0·29
47	53·7	40 −	16·9	12 −	29·96	43·3 +	0·18
48	56·1	35 −	17·1	15 −	29·64	48·0 +	0·44
49	56·8	41 −	14·3	11 −	30·28	43·3 +	0·00
50	56·2	30 −	14·9	9 −	30·42	33·6 −	0·00
51	53·6	35 −	12·4	11 −	29·95	45·4 +	0·06
52	52·7	28 −	12·1	7 −	29·94	42·9 +	0·17
53	52·7	31 −	12·1	12 −	29·71	39·0 +	0·33

N.B.—The signs + and − simply indicate, of the figures to which they are attached, above or below the average without reference to the amount of excess or diminution.

* Records of observations, made in the Royal Botanic Society's Garden in Regent's Park, prior to and during the period of the outbreak, have also been examined; and the result of these observations is to show a practical identity of meteorological conditions at Greenwich and in Marylebone.

App. No. 6.

Enteric Fever in West London, by Mr. Radcliffe and Mr. Power.

TABLE II.—MEAN DAILY READINGS of the BAROMETER, and Mean Daily Temperature, with the Rainfall day-by-day at the Radcliffe Observatory, Oxford, for the Months of June and July 1873, and the Differences of the Barometer and Thermometer from the Monthly Mean of Five previous Years.

Date.	Barometer reduced to 32°.	Excess.	Mean Temperature.	Excess	Rain.	Date.	Barometer reduced to 32°.	Excess.	Mean Temperature.	Excess	Rain.
1873.	Inches.	Inches	°	°	Ins.	1873.	Inches.	Inches.	°	°	Ins.
June 1	29·814	−0·004	51·5	−7·0	—	July 1	29·812	+0·048	61·8	−2·0	—
2	29·734	−0·083	53·6	−4·9	0·149	2	29·748	−0·016	62·1	−1·7	0·004
3	29·628	−0·189	58·7	+0·2	—	3	29·546	−0·218	62·1	−1·7	0·007
4	29·618	−0·201	60·2	+1·7	0·649	4	29·575	−0·189	57·4	−6·4	0·215
5	29·724	−0·093	56·3	−2·2	—	5	29·568	−0·198	59·5	−4·3	0·035
6	29·966	+0·149	51·9	−6·6	—	6	29·806	+0·042	60·1	−2·7	—
7	30·022	+0·205	54·4	−4·1	—	7	29·869	+0·105	64·5	+0·7	—
8	29·923	+0·106	58·0	−0·5	—	8	29·874	+0·110	65·7	+1·9	—
9	29·632	−0·185	57·3	−1·2	—	9	29·797	+0·033	62·2	−1·6	0·004
10	29·480	−0·337	57·3	−1·2	0·020	10	29·654	−0·110	61·2	+2·6	—
11	29·397	−0·420	56·6	−1·9	—	11	29·570	−0·194	60·1	−2·7	—
12	29·339	−0·478	58·0	−0·5	0·020	12	29·461	−0·303	57·8	−6·0	0·220
13	29·493	−0·324	54·3	−4·2	0·510	13	29·349	−0·415	56·1	−7·7	0·960
14	29·564	−0·253	56·8	−1·7	0·023	14	29·488	−0·276	55·2	−8·6	0·360
15	29·666	−0·151	57·4	−1·1	—	15	29·688	−0·076	58·4	−5·4	0·035
16	29·763	−0·054	58·8	+0·3	—	16	29·884	+0·120	61·5	−2·3	—
17	29·766	−0·051	59·8	+1·3	0·044	17	29·748	−0·016	63·2	−0·6	0·053
18	29·836	+0·019	61·5	+3·0	—	18	29·835	+0·071	58·2	−5·6	—
19	29·911	+0·094	58·1	−0·4	0·010	19	29·940	+0·176	61·1	−2·7	—
20	30·006	+0·189	63·3	+4·8	—	20	29·947	+0·183	67·6	+3·8	—
21	29·964	+0·147	66·2	+7·7	—	21	29·850	+0·086	75·2	+11·4	—
22	29·828	+0·009	62·4	+3·9	—	22	29·715	−0·049	72·8	+9·0	0·053
23	29·822	+0·005	60·3	+1·8	0·028	23	29·781	+0·017	65·3	+1·5	—
24	29·684	−0·133	58·0	−0·5	0·018	24	29·795	+0·031	67·4	+3·6	—
25	29·918	+0·101	56·4	−2·1	—	25	29·732	−0·032	64·2	+0·4	0·110
26	29·915	+0·098	60·5	+2·0	—	26	29·729	−0·035	63·3	−0·5	—
27	29·861	+0·044	60·7	+2·2	—	27	29·763	−0·001	61·1	−2·7	—
28	29·819	+0·002	62·1	+3·6	—	28	29·756	−0·008	62·7	−1·1	—
29	29·579	−0·238	61·4	+2·9	1·236	29	29·715	−0·049	65·3	+1·5	0·096
30	29·692	−0·125	58·5	0·0	0·072	30	29·773	+0·009	65·3	+1·5	0·065
						31	29·827	+0·063	62·7	−1·1	—

MEAN MONTHLY HEIGHTS of the BAROMETER and THERMOMETER for the months of June and July in the years 1868–72, inclusive.

June.	Barometer.	Thermometer.	July.	Barometer.	Thermometer.
	Inches.	°		Inches.	°
1868	29·949	61·8	1868	29·864	66·0
1869	29·871	56·5	1869	29·864	64·0
1870	29·891	61·1	1870	29·761	64·9
1871	29·708	55·2	1871	29·621	60·5
1872	29·668	58·0	1872	29·708	63·8
Mean -	29·817	58·5	Mean -	29·764	63·8

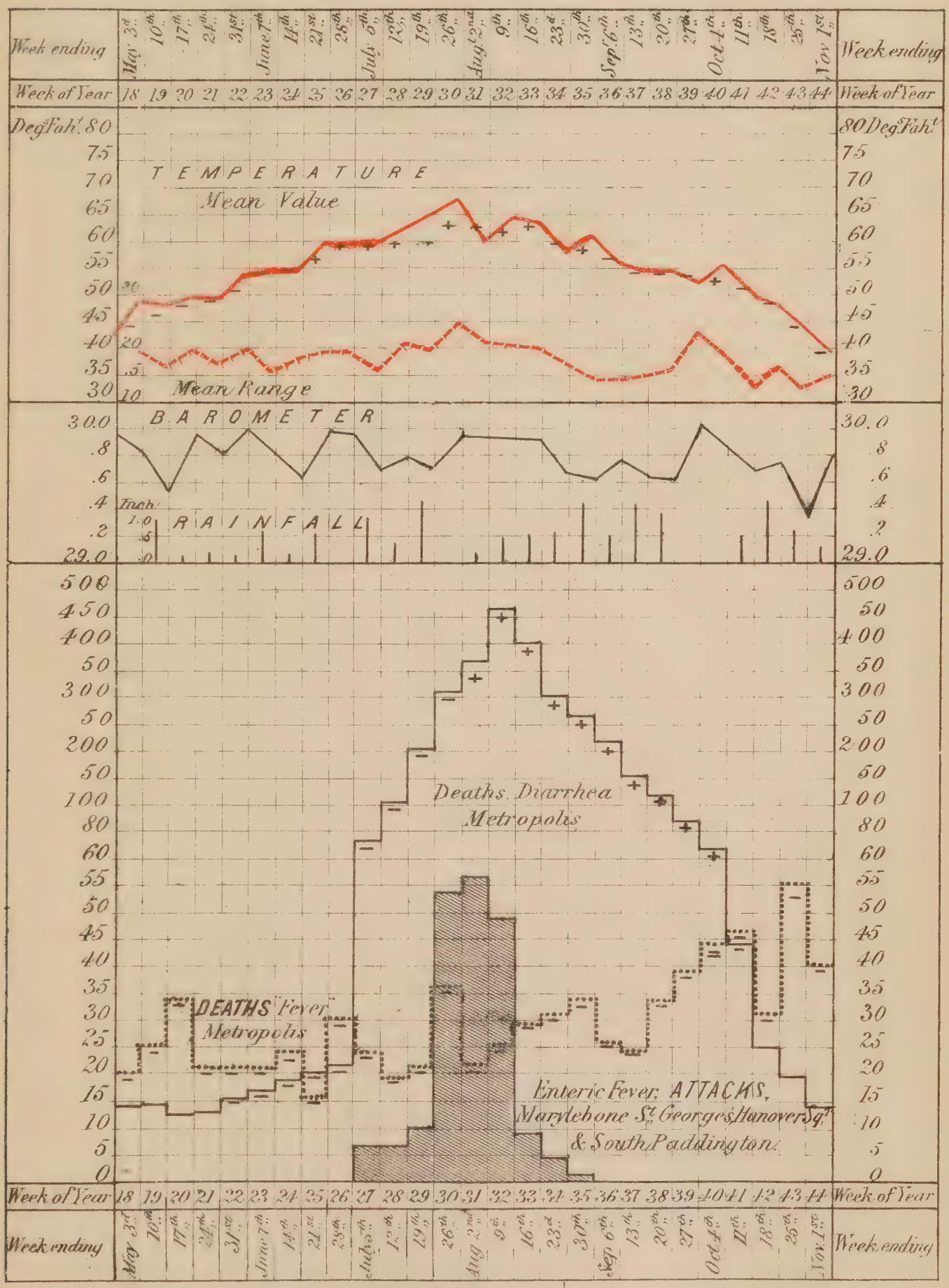
(Signed) ROBERT MAIN.

February 10, 1874.

(To Illustrate Report on Prevalence of Enteric Fever in certain districts of West London.)

APPENDIX DIAGRAM No. I.

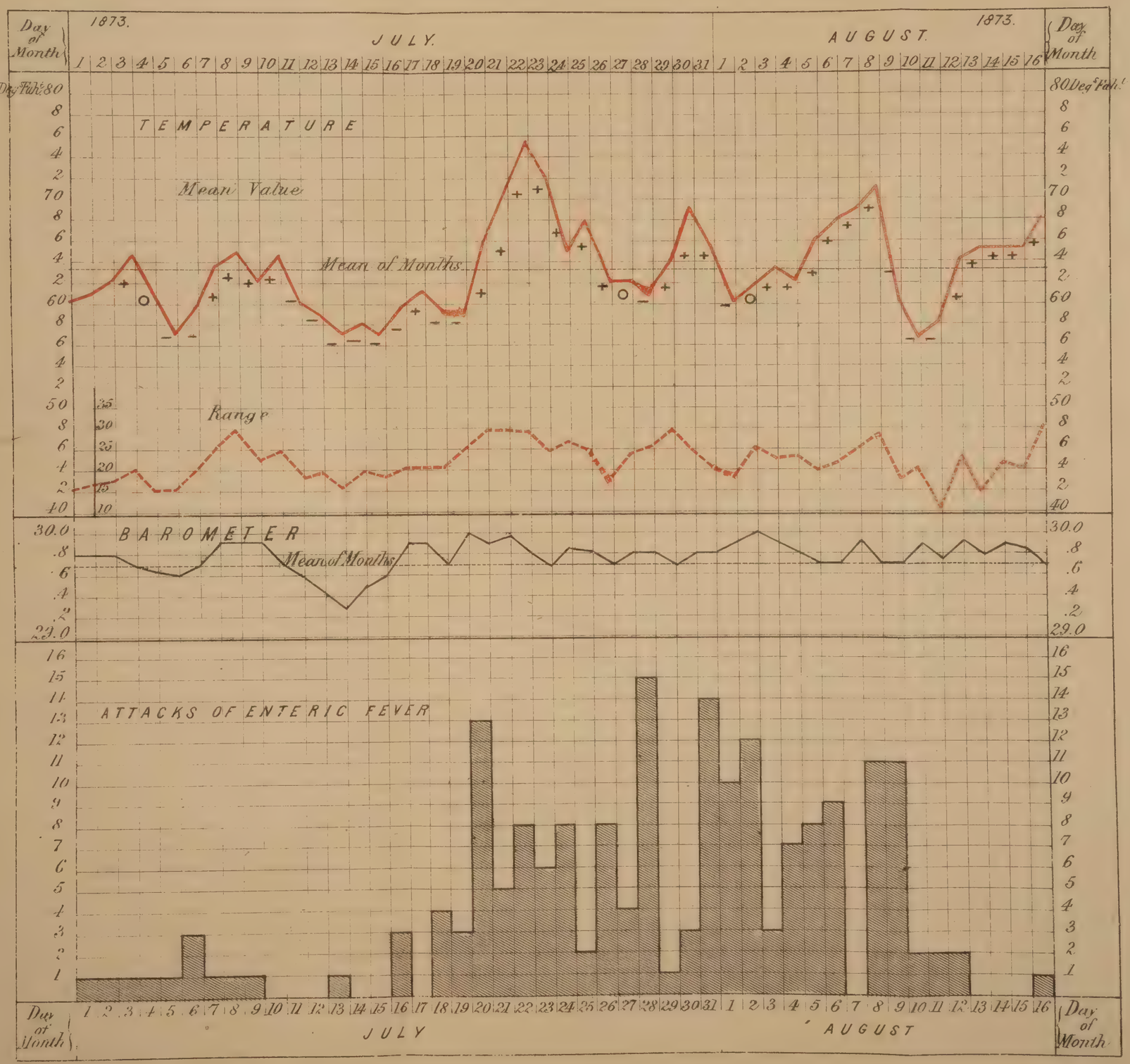
Showing the relations of the Outbreak to the Mortality from "Fever" and "Diarrhea" in the Metropolis generally to certain Meteorological Data.


Week ending
May 3d. 10th 17th 24th 31st June 7th 14th 21st 28th July 5th 12th 19th 26th Aug 2nd 9th 16th 23d 30th Sep 6th 13th 20th 27th Oct 4th 11th 18th 25th Nov 1st
Week of Year
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Deg Fah
TEMPERATURE
Mean Value
Mean Range
BAROMETER
RAINFALL
Inch
Deaths Diarrhea Metropolis
DEATHS "Fever" Metropolis
Enteric Fever ATTACKS, Marylebone St. George's Hanover Sq. & South Paddington.

(To illustrate Report on Prevalence of Enteric Fever in certain districts of West London

APPENDIX DIAGRAM Nº II

Showing the relation of the attacks of Enteric Fever, day by day, during the Outbreak, to certain Meteorological Data.

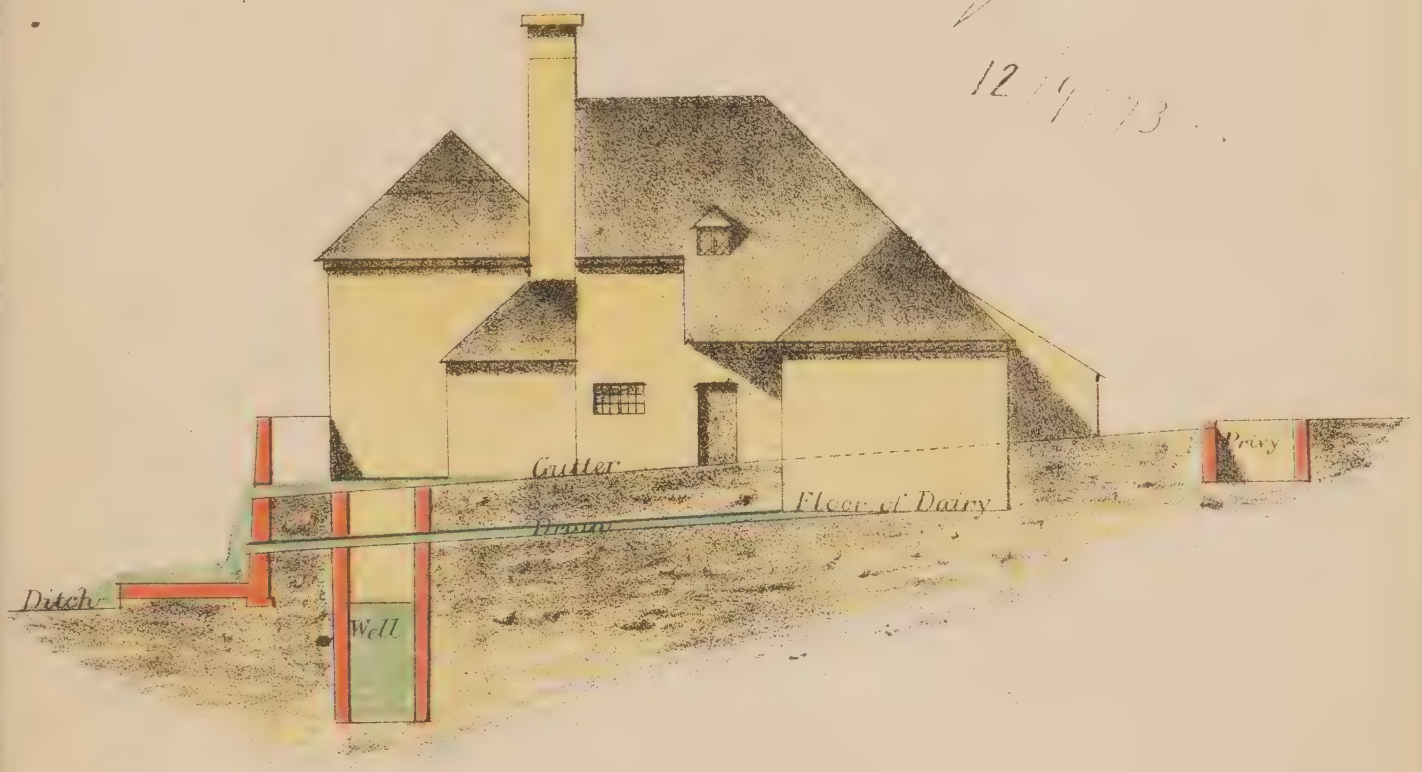


Dangerfield. Lith. London

(To illustrate Report on Prevalence of Enteric Fever in West London)

SECTIONS OF CHILTON GROVE FARM.

Henry Morris
Surveyor
12/4/73.



SECTION FROM NORTH TO SOUTH.

SECTION FROM WEST TO EAST.

Scale 1 Inch 16 Feet.

Dangerfield, Lith. London

8 MAY

(To illustrate Report on Prevalence of Enteric Fever in West London.)

PLAN OF
CHILTON GROVE FARM

Henry Morris
Surveyor
12/9/73

GROUND PLAN

Scale 1 Inch = 21⅓

N.B. The position of the Ash-heap and of the Drain for the liquid dung is drawn from a plan and notes made by Mr. Radcliffe, 13th Augt. 1873.

Dangerfield, Lith., 22, Bedford St. Covent Garden

No. 7.

Report by Mr. J. Netten Radcliffe on certain Means of preventing Excrement Nuisances in Towns and Villages.

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Preliminary.

In 1869, Dr. Buchanan and I, as inspectors in the Medical Department of the Privy Council, made an inquiry concerning the systems then in use in various northern towns for dealing with excrement. The considerations which prompted that inquiry were thus stated in the introduction to the report in which we gave the results * :— *Privy Council Inquiry of* 1869.

"The propagation of certain epidemic diseases, especially cholera, enteric fever, and diarrhœa, among communities, as the result of excremental pollution of air and water, is one of the best established facts of sanitary medicine. It is a fact which has been admitted for over a century, and still various inquiries of this department (themselves affording repeated evidence of its truth and importance) are showing that it remains without practical recognition by a large proportion of the health authorities of the kingdom. It must be allowed

* On the Systems in use in various Northern Towns for dealing with Excrement.—Twelfth Report of the Medical Officer of the Privy Council, 1869.

that this inaction has been mainly due to the ignorance, or the parsimony, or the carelessness of the bodies to which sanitary matters have been entrusted, but the whole extent of the inaction cannot thus be explained. Certain authorities have, indeed, been glad to have, as a handy excuse for delaying to take any step whatever towards amendment, the want of agreement throughout the world as to the means of amendment. But there are other authorities which have fully recognized the importance of efficient and safe excrement removal, which have made themselves acquainted with the defects of their own arrangements, and which have seriously inquired as to means of improvement; and yet even these authorities have, after all, been as little satisfied with any proposed alternative as with their own acknowledgedly bad system. No one who knows what many of these latter bodies have done in other ways of sanitary improvement, especially in the matter of water supply, can imagine that inaction in their case is without some reasonable cause. For the health of their communities has justifiably not been the only care with such authorities. There are other considerations which they have held in view; and the chief of these, in a sanitary aspect, is that the disposal of the excrement shall be done without detriment to other people; while in an economical point of view the question has pressed how there shall be restored to the earth for the sustenance of vegetation the elements which have been taken from the earth by vegetation for the sustenance of animals. The attainment of such objects has affected materially the ability and the disposition of authorities to deal with the primary sanitary aspects of excrement disposal.

"The department, in its investigations as to the local prevalence of disease, has been constantly brought face to face with this state of matters. Its inspectors, when they found places wanting in proper arrangements for excrement-disposal, have of course insisted on the mischief arising from this source, and on the need for improvement. But, especially where the local authority has itself been conscious of defects in its arrangements, and has already entertained schemes of amendment, yet without practical result, advice in general terms has been felt to be somewhat vague and unpractical. Evidently it would be helpful to the action of the local authorities in such circumstances to know what plans are being carried out in various other towns of the kingdom, and to have materials before them for judging how far any of such plans might prove applicable to their own wants, at all events for immediate purposes, and until better agreement should be attained as to the constructive arrangements that constitute perfection in regard of excrement-disposal."

With this object in view we examined and reported upon the arrangements for excrement-disposal in various northern towns; and in addition to describing such of them in detail as we thought it might be useful for other places to know, we endeavoured to determine, from the results of the investigation, certain general principles of action in the abatement of excrement nuisances which might serve as a guide to local authorities.

Scope of present inquiry.

The present inquiry (1874), carried out under the Local Government Board, included also a further investigation of the dry-earth system, which had been dealt with and reported upon by Dr. Buchanan* independently in the first inquiry. The inquiry was directed to ascertain the additional experience which had been gained in the working of the various systems of excrement-disposal described in the previous reports, and generally such new experience as might have been obtained on the subject during the five years which had elapsed since the first inquiry; and for this latter purpose it was extended over a wider area. The subject of nuisance from "slops," which is in some sort complementary to that of excrement nuisance, was, moreover, included in the present inquiry.

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* On the Dry-Earth System of dealing with Excrement.—Twelfth Report of Medical Officer of Privy Council, 1869.

In pursuit of this inquiry the following places were visited :—

1. Aldbury.
*2. Birmingham.
3. Birkenhead.
4. Bradford.
5. Bristol.
*6. Broadmoor.
7. Butleigh.
8. Cockermouth.
9. Dalmuir.
*10. Dorchester.
11. Eastwick.
*12. Edinburgh.
13. Exeter.
14. Gaddesden (Little).
*15. Glasgow and vicinity.
16. Gloucester.
*17. Hull.
*18. Halifax.
*19. Halton.
20. Hereford.
*21. Leeds and adjoining district.
22. Lands End district.
*23. Lancaster.
*24. Liverpool.
*25. Manchester.
*26. Nottingham.
27. Oldham.
28. Paisley.
*29. Rochdale.
*30. Salford.
31. Skiningrove (Yorkshire).
*32. Saltaire.
33. Shenfield, Essex.
34. Shildon (Bishop Auckland).
35. Sunderland.
36. Scarborough.
37. Slough.
38. Tring.
39. Upleatham.
40. Wakefield.
41. Wandsworth.
42. Warrington.
43. Westbury-on-Trym.
44. Whittingham.
45. Walsall.
48. Worksop.
*49. Wimbledon Camp.

In the following report I do not propose to give in detail the results of inspection in each place, but to describe only such of the several inspections as appear to me most instructive in their bearing upon the subject of the report.

A.—Summary Report.

I.—General Observations.

Progressive advance in adoption of measures of excrement disposal.

Reviewing the general results of the inquiry it is desirable to state, first, that while it has disclosed a very assuring advance, during the past five years, in measures adopted in numerous places for the abatement of excrement nuisance and some important modifications of detail in the measures adopted, the conclusions of the previous inquiry remain substantially unaffected. I may be permitted also to remark, that in the course of this inquiry frequent and most gratifying testimony was given of the usefulness of the previous inquiry as helpful of the action of local authorities, for which purpose it had been originally designed.

Necessity for alternative measures.

This inquiry, as the previous inquiry, was restricted to measures of abating excrement nuisance other than water-sewerage, except in so far as it seemed advisable to include particular adaptations of this mode of excrement-disposal to the wants of those sections of a community which are most dependent upon public arrangements and public supervision. The inquiry, in fact, began at the point where it had been assumed,

* The 17 places marked with an asterisk in the above list had been visited in the first inquiry, as also had been two places, not now revisited, Preston and Stamford.

for whatever reasons, that the applicability of water-sewerage to the needs of a community, in respect to excrement-disposal ended ; and it designedly included within its range only so much of the question of water-sewerage as was necessary to elucidate certain presumed difficulties of application to particular sections of the poorer classes. It was simple matter of observation that, previous to the first inquiry, water-sewerage which to that time had been the only system of abating excrement nuisance generally advocated in this country, had been regarded as inapplicable to the wants of numerous places where neither ignorance, nor parsimony, nor indifference to sanitary responsibilities could be justly assumed of the local authorities ; and that, excepting only such measures as were described in the report of Dr. Buchanan and myself, in these and many other places, sanitary work to this particular end had come to a dead lock. The unquestionable and preponderating advantages of a system of water-sewerage in regard to decency, convenience, and wholesomeness, as compared with other systems of excrement disposal then commonly in use, had naturally so influenced the judgment of most persons concerned in promoting sanitary work, as to cause them to desire its general introduction. It was not until the institution of the system of medical inspections as to local prevalences of disease, established by the Privy Council, came into operation, that it began to be understood how partially water sewerage had been carried into operation in the kingdom since the enactment of the Public Health Act, 1848, and how grave a state of things had persisted in many places, and become aggravated in others, from lack of some alternative methods of abating excrement nuisance. I do not propose to discuss here the various circumstances under which this had come to pass. It is sufficient for my present purpose to state that they commonly depended either upon local peculiarities which precluded the adoption of water-sewerage, except, perhaps, under conditions of combination of authorities too remote to be contemplated as a practical matter ; or upon local habits of thought and practice which gave little hope of speedy change, and which must be recognised as elements of judgment in making recommendations for the sanitary amelioration of a place if any hope were to be entertained of these having effect. It had become clearly obvious, in fact, at the time of the first inquiry, that the exclusive recommendation of one particular method of excrement-disposal could no longer have place, if the inspections referred to were to be productive of good, the dead lock in which sanitary authorities were very generally found loosened, and sanitary work throughout the kingdom quickened. This broader view of the question, moreover, appeared to be more consistent with the intentions of the Legislature as indicated in the various Sanitary Acts. For these Acts permit one or other or all of several different ways of depositing excrement, under the general condition that nuisance is to be avoided in the arrangements adopted.

While these considerations had arisen out of the medical inspections instituted by the Privy Council, and had in effect determined the inquiry which was carried out by Dr. Buchanan and myself under the instructions of their Lordships, the local authorities of several northern towns had given serious attention to the same subject as a matter of local administration. Although rejecting a general system of water-sewerage, they had regarded with increasing anxiety the persistence or growth of excrement nuisance within their districts, and, as shown in our report, had cast about to seek its abatement in several ways, other than water sewerage, having at the same time regard to the utilization of the excrement. The wisdom of this course of action, viewed from a medical stand point and gauged by a large dimi-

nution of excrement nuisance in the places where it had been most successfully carried out, was made abundantly clear in the first inquiry, and has been amply confirmed in the present inquiry. The necessity of such a course must, indeed, be accepted if any general progress is to be made in dealing with excrement nuisance throughout the kingdom. Upon this question the experience of the Medical Department, based upon the minute study of local prevalences of disease, is in complete accord with the not less important results of local experience in overcoming practical difficulties connected with excrement nuisance. It was inferred from the first kind of experience, and it is the obvious deduction from the latter kind of experience that the requirements of each place as to excrement-disposal should be judged not from any general preconception of what is the best mode of such disposal, but from a careful consideration of the various modes at command which would best meet those requirements and the habits of the people. Without seeking to suggest a limit to human invention and ingenuity, I may say that nothing in the course of this inquiry has given even an inkling of support to a rather prevalent notion that some perfect scheme of excrement-disposal, applicable to all sorts of places irrespectively, may be looked for, and action properly deferred until such scheme be forthcoming. The more closely the facts are looked into relating to the different conditions under which various populations live, the more surely I am persuaded will the conclusion be arrived at that no reasonable ground exists for anticipating the fulfilment of such hope within any period of time which would justify a local authority delaying action on account of it.

II.—Systems of Excrement-Disposal Observed.

(*a.*) *General Considerations.*

Systems of excrement-disposal observed, 1874.

In one only of the places visited in the course of the inquiry did a uniform system of excrement-disposal exist. Bristol has a general system of water-sewerage, and this was the only town having such a system, properly so-called, which came within the scope of the inquiry. In the other places waterclosets existed as a part of the system of excrement-disposal, in some places many in number, in some few.

Water-closets existed in conjunction with a plan for the daily removal of excremental matters from localities where closets could not be fixed, and with a plan of public dry-ash closets in Edinburgh ; with midden-closets in Birkenhead, Bradford, Eastwick, Hull, Liverpool, Worksop, &c. ; with midden and pail closets in Birmingham, Halifax, Leeds, Manchester, Nottingham, Rochdale, Salford, Sunderland, Scarborough, Wakefield, &c. ; with midden-closets and earth-closets in Lancaster, &c., and with midden, pail, and charcoal-closets in Glasgow. In a few rural districts only did waterclosets wholly disappear; and certain hamlets and villages were observed in which the midden-closet (Upleatham mines) or the midden-closet and earth-closet (Skiningrove, Shildon, &c.), or the midden-closet and pail-closet (villages near Cockermouth) alone existed.

Principles of excrement-disposal.

This conjunction of different plans in various towns represents mainly, in the present state of things, a transitional condition from the common middenstead privy with its great accumulation of filth and abominable offensiveness, to a better system. In almost every place the watercloset has become, from the sentiment of cleanliness attending its use and the privacy which attaches to it as commonly adapted to buildings, the favourite method of the educated and wealthy ; and amid much discussion of the subject, I have seen no indications of this prepossession in its favour undergoing any great change. It will be more difficult for those classes to unlearn the use of the watercloset and

adopt any of the plans yet offered in substitution for it, than to unlearn the use of the midden-closet for which it was substituted. In some of the places visited, in Edinburgh and Glasgow, for example, the tendency is to make a watercloset system general, and existing supplementary scavenging of excrement, by pail-closets or improved midden-closets, must be regarded as provisional pending the solution of difficulties in the structural arrangements of houses and in the disposal of sewage; although as yet no limit can be indicated when these provisional arrangements may end. In Hull an improved midden system is the complement of water-sewerage; and in Rochdale and Manchester a pail-system is rapidly becoming so. This combination of two or more methods of excrement-disposal in the same place is commonly the result of deliberate efforts to abate a grave nuisance consistently with the believed special wants of a population. In those places where plans complementary to a watercloset system have been most successfully introduced (*e.g.*, Edinburgh, Hull, Rochdale, Manchester, Nottingham), success has been obtained from certain well-defined principles of action which appear to me to be essential to successful work of the same kind elsewhere.

Frequency of removal.

Foremost amongst these, and regulating all that follows, is *the frequency of removal of deposited excrement.* The arrangements to this end must of necessity govern all other arrangements, and it is requisite that they should be first determined by a local authority. The peculiar advantage of the watercloset is that with properly arranged and rightly constructed drains and sewers, and duly supplied with water, it admits of excremental matter being removed without offensiveness beyond the precincts of a house and from amidst a community immediately after it has been deposited.* Dr. Buchanan and I, in discussing the period during which excrement should be permitted to remain in the vicinity of dwellings, expressed ourselves, in 1869, in the following words, which I reiterate now :—

"In the present imperfect state of our knowledge of the conditions under which fæcal diseases spread, we do not feel ourselves entitled to say at what time, after being passed, dejections are or may (under various external circumstances) become dangerous to health. We cannot say this either in regard of healthy excrement, or of that passed from persons affected with disease, specific or other; but we think it may probably be taken as sufficiently true for practical purposes that there is little chance of mischief from the storage of excrement *for a day*, even though along with healthy excrement that of persons affected, for example, by enteric fever should, without proper disinfection, chance occasionally to be included. We propose, then, to regard *complete removal of all excrement within a day* as practically constituting safety in the case where excrement is unmixed, or is only mixed with ashes."

In Edinburgh only has such a frequent removal as is here suggested been successfully carried out by scavenging arrangements, and it appears to have been very generally thought, I hold most mistakenly, that the peculiar circumstances which originally led there to the adoption of this

* The fundamental principles of house drainage and sewerage are set forth in the "*Suggestions as to the preparation of Plans as to Main Sewerage and Drainage* "*and as to Water Supply,*" prepared by Mr. Robert Rawlinson, C.B., C.E., Chief Inspector of the Engineer's Department, and published under the authority of the Board. Particular applications of these principles, essential to the inoffensive removal of excremental matters by the watercloset, consist (*a*) of the introduction in the course of the drain, after it has passed outside the walls of the building, of a contrivance, forming ordinarily a trap, open to the air, for the purpose of cutting off direct communication between the sewer or other termination of the drain and the portion of the drain and its connections within the house; and (*b*) of abundant provision for the ventilation of soil-pipe, drain, and sewer.

arrangement remove it from consideration elsewhere. Leeds is now engaged experimentally in a plan of daily scavenging of its worst district. In this town the conditions are very similar to those which are found in many English towns. The mode of scavenging adopted here may probably provoke objection, but the enormous advantage to the district by the systematic daily removal of all excremental filth cannot be gainsaid, and it will be a deplorable result if from any matter of remediable detail, or for financial reasons, this important experiment should prove abortive. In not a few towns (as for instance Cardiff) all dry house refuse is removed daily, and I am unable to believe that what has been found practicable with this comparatively harmless stuff should not be practicable of excremental matters.

The frequency of the scavenging governs the size of the receptacles for excrement. Hence the primary consideration for a local authority in respect to the abatement of excrement nuisance is the arrangement of the "night-soil scavenging," so-called. In Hull, and Rochdale, and Manchester, and Nottingham, and the towns which are systematically using a pail system, scavenging at weekly intervals has been adopted as the most practicable general arrangement, and the middensteads of Hull and the pails of the pail-closet towns have a capacity regulated by this frequency of removal. That is to say, they are designed to hold a week's excrement of a household and no more.

Capacity of receptacle.

The want of clear recognition of the principle that systematic frequent scavenging is the initial consideration in improved methods of excrement-disposal other than water-sewerage has led to much fruitless work in attempts to improve the midden system. *The measure of the capacity of the receptacle should be the frequency of scavenging.* With even a weekly scavenging it is obvious that the receptacle, if no larger than is required to contain the excrement in the intervals of removal, will almost of necessity be free from the evils which attach to the structure of the old middenstead privy. There is no necessity for a privy pit, as commonly understood, and all the evils of soakage of excrement into the soil and saturation of walls in addition to accumulation are at once done away with, while the structural requirements to prevent offensiveness are rendered of the greatest simplicity ; and better still, it becomes at once possible to substitute a handy moveable receptacle with all its advantages for a fixed one.

(*b.*) *Particular Modes of Excrement-disposal observed and the Results of Observation thereon.*

The several modes of excrement-disposal observed in the course of the inquiry may be classified as follows :

1. *The Midden System.*
2. *The Pail System.*
3. *The Water System.*
4. *The Earth System.*
5. *The Charcoal System.*

On each of these systems, with the exception of the charcoal system, and with certain limitations as to the watercloset system, Dr. Buchanan and I reported in 1869, and we then endeavoured to set forth the principles which should govern their use. These principles remain wholly unaffected by the results of the present inquiry, and only such change is necessary in the phraseology that we then used in stating them, as is requisite to include sundry modifications of detail.

App. No. 7.

On Excrement Nuisances, by Mr. J. Netten Radcliffe.

The Midden System.

The different arrangements observed in operation on this system were as follows:

1. Midden-Closets with fixed Receptacles:—
   - *a. Of old type*, old parts of almost all towns.
   - *b. With middensteads of large size, and permitting much accumulation, but compulsorily supplied with some means for keeping the contents dry (covers, drains, or both), and for preventing soakage into the earth.* Leeds, Birmingham, Nottingham, Bradford.
   - *c. The same* (though generally with smaller middensteads) *with the addition of special construction aiming at the effectual covering of excrement by ashes—*
     - *By sloping bottom* (Nottingham, Salford).
     - *By hinged seats or steps* (Manchester, Salford, Saltaire).
     - *By grid and shoot* (Bradford).
     - *By shoot* (Glasgow).
   - *d. The same arrangement, but with the middenstead reduced to a mere space under the seat* (Hull).

2. Midden-Closets with moveable Receptacles.
   - *A tub used as middenstead and placed beneath the privy seat (Nottingham).*

1. *Midden-Closets with fixed Receptacles.*

Midden-closets with fixed receptacles.

Starting from the old-fashioned pattern of midden-closet as the standard of all that is utterly wrong, the experience of both inquiries shows that midden-closets may be improved, and that if the following conditions be observed they may be regarded as tolerable:—

Position.

1. As to *position.*—It should not be permissible for a midden-closet to be placed under rooms or workshops, or with its walls in juxtaposition with those of a house. Whatever stone, brick, or cement be used in building the middenstead (privy-pit) it must be assumed (regard being given to the conditions under which the work of construction is commonly executed) that some amount of oozing will occasionally, if not habitually, take place. Again, a midden should not be permitted in any place from which its contents cannot be removed without taking them through houses. Dr. Trench's code of regulations under which middens are tolerated in Liverpool expresses these principles in detail.*

Materials.

2. As to *materials.*—The materials of which the middenstead is con-

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* This code (see p. 205), provides against—

" 1. Midden privies inside houses.
" 2. Midden privies emptied through houses.
" 3. Midden privies situated beneath rooms.
" 4. Tunnel middens of every description.
" 5. Combined open middens supplying many tenements and placed near to inhabited rooms.
" 6. Midden privies of private houses clustered together in a blind court.
" 7. Midden privies of private houses in close confined yards or situated beneath windows, or abutting on walls of houses, or within two feet of the lower windows, or of the door of the house.
" 8. Midden privies of courts.
" 9. Midden privies abutting on, or opening directly into, streets and thoroughfares, and emptied before the doors and windows of houses.
" 10. Midden privies of front houses when emptied through a court.
" 11. Midden privies beneath the footpath of the street, and emptied through a grid on the footpath.
" 12. Midden privies of many houses, when collected together as a kind of amphitheatre, as is seen in particular groups of streets."

structed should be to the greatest possible extent non-porous, that liquid may be prevented soaking into as well as through them.

3. As to *roofing*.—It is of material importance that a middenstead should be roofed over, for all water helps decomposition, besides increasing the difficulty of removing the contents. *Roofing.*

4. As to *ventilation*.—When the middenstead is roofed ventilation should be insisted upon. Whether this should be effected by shaft or otherwise will depend upon the position of the privy to the house or to neighbouring houses. In Manchester special ventilation of the middenstead by shaft is ordered on account of the habitual contiguity of the privy to the house, and in the conversion of midden-closets into pail-closets now going on in that city, it is still held advisable to retain the ventilating shaft for the place containing the pails. The closet, as distinguished from the middenstead, should also be freely ventilated. It has been particularly observed during the recent inquiry that differences of offensiveness in midden-closets were greatly dependent upon the free access of air both to the middenstead and the closet. *Ventilation.*

5. As to *drainage*.—Drainage of the middenstead is fatal to any possible defence of a midden system at all. If urine with the liquid and partially dissolved fœces be conveyed out of the middenstead into sewers, there can be no sufficient reason either commercial or sanitary for not sending all excrement together along sewers. Drainage is fallacious as the means of continuously draining off the liquid contents of a middenstead, and thus promoting dryness of contents, as was observed everywhere in wetness of open middensteads presumed to be drained; and dryness can be secured in other and more effectual ways. Drainage proves, moreover, a source of hidden mischief by permitting liquid and partially dissolved excrement to trickle into the drain, carrying along with it fine ashes, the mingled excrement and ashes not unfrequently almost wholly blocking up the drain. In illustration of this state of things, the result of explorations made in Manchester into the state of drains communicating with middensteads, and given in the report on that city, may be referred to (p. 43). *Drainage.*

6. As to *size* and *shape*.—It is most desirable that the area from which foulness might sink into the soil should be as far as possible within sight, not sunk beneath the surface; and then it should be as small as can be contrived. In this view, as adapted to a single family, the new Hull middenstead may be indicated as the most satisfactory which has come under observation; as adapted to several families, the new Glasgow middenstead. *Size and shape.*

The *Hull middenstead*, which is designed to serve for a week for one family, consists solely of the space under the closet seat, and its floor, commencing above the ground level (on the level of the closet floor), is formed by a flag which slopes downwards to the back wall at the ground level there.

The *Glasgow middenstead* is proportionately of smaller size than the Hull middenstead, and is formed by the space beneath the closet seat and about equal space in rear. The floor is slightly sunk beneath the level of the ground, and in this respect the construction is objectionable, and should be changed to the Hull pattern. This middenstead is arranged to contain two days' accumulation of excrement and house-refuse of the families using it.

Since largeness of size means infrequency of emptying, the middensteads can scarcely be too small, and by far the most satisfactory constructions which have come under observation, for the particular requirements they were designed to meet, are the new Hull and Glasgow middensteads.

In some instances the *middenstead bottom* has been rounded, as in plans approved at Nottingham and elsewhere, with the object of the ashes becoming better mixed with the excrement in the middenstead. Experience of this arrangement proves that the end sought is not obtained by it. Regard being had to the nature of ordinary building materials, as meeting the condition of imperviousness, a flat surface of stone or slate appears to answer best.

Disposition of contents.

7. *Disposition of contents.*—The *covering up* of the excrement with ashes and dry house refuse, or by ashes alone, should be considered as essential in any scheme for the retention of middensteads. Numerous plans of so-called improved middensteads have come under observation principally designed to secure this end, but the arrangements of the Hull and the Glasgow middensteads have alone in practice appeared to ensure any reasonable degree of success. In the Hull middenstead the ashes and other dry house refuse are simply cast through the closet seat upon the excrement; in the Glasgow middenstead they are thrown into it behind the closet seat, but are directed upon the excrement by an inclined plane. In both instances the small capacity of the receptacle is an element of success. Other schemes, intended to diminish the offensiveness of *large* middensteads, as observed in Manchester, Salford, Nottingham, and elsewhere, have uniformly failed.

The indiscriminate casting of ashes and house refuse upon the excrement diminishes the value of the latter as manure, and many plans exist for covering the excrement with fine ash only, the cinders being separated for reburning. The greater number of these plans are designed somewhat after the fashion of the Bradford plan, and in practice, so far as they have come under observation, have proved quite futile. In the Bradford plan the sifting of the ashes is effected by a riddle so placed in rear of the closet, that the fine ash as a rule fall clear of the excrement. In the dry-ash closets of Manchester and of Morrell's patent it has been shown that it is quite possible to devise and ensure the use of sifters so as to secure the covering up of the excrement. It may be possible to adapt the same means to the common middenstead, but no examples of such adaptation have come under observation.

Access.

8. As to *access.*—Removal of the contents of the midden through the house has already been condemned. The scavengers' access to the privy, where the cleansing is done by the public servants, should invariably be direct from without; and if the middenstead be not simply the space beneath the seat, the opening for removal of the contents should be under his sole control.

Closets.

9. As to *construction of closet.*—The lower parts of the wall and floor should be of impervious material, and the floor should slope somewhat towards the door. In this way a broom and pail of water will well clean out any casual impurity. The closet, as already stated, should be ventilated as thoroughly as practicable.

Holding in view the conditions seen in actual practice, and combining them so as to give what appears to be the least objectionable forms of midden-closet with fixed receptacles, the following results are obtained:—

(*a.*) A closet, removed from the house, roofed and floored with sloping flags, the upright of the seat and the seat itself moveable; the space under the seat, constituting the middenstead, made of non-porous material, with its floor at the level of the ground, sloping backwards, and undrained. If the quantity of ashes applied to the excrement with this construction do not suffice to keep the contents solid, there cannot be any presumption in

favour of a midden-closet at all. The roof of the closet serves to keep rain out of the middenstead, and as much ventilation as procurable is given. The type of this simple, inexpensive, and least harmful midden-closet is found at Hull. The upright of the closet-seat, however, in the Hull plan, has the defect of being porous.

(*b.*) The same construction as to roof, floor, and absence of drainage, but with the closet seat fixed, and the space beneath it extended sufficiently back to admit of the ashes and house refuse being thrown upon the excrement, directed by an inclined plane, from the rear. The type of this equally simple privy is found at Glasgow.

Having arrived at these particular modifications of the midden-closet, as being those from which the worst defects of the system are found absent, it must be observed, that *the one great condition under which such closets are alone permissible, is the frequent removal of their contents.* It is unnecessary to dwell upon a sanitary truth so certain as that excrement, if it is to be stored at all in the vicinity of houses, along with no better guard than ashes, should be stored for the shortest possible space of time. In Glasgow the contents are presumably removed every two days; in Hull once a week; and the capacity of the middensteads is calculated in each case to contain only the filth and refuse which accumulates in the intervals of the scavengers' visits. The plan of weekly scavenging of night-soil is at present held alone feasible as a general practice in those towns which have adopted systematic measures for abating midden nuisance; but special arrangements are commonly made for scavenging at more frequent intervals particular houses, such as lodging houses, or districts where greater frequency is obviously called for. The important principle in fact is steadily becoming recognized, that where it has not been found practicable as yet to bring the intervals of scavenging for a whole place within those limits which considerations of health render desirable, a different rule should be applied to the least wholesome localities of the place, by scavenging these more frequently—thus regulating the scavenging by the greater or less degrees of filthiness or liability to filthiness of particular localities.

2. *Midden-Closets with moveable Receptacles.*

Midden-Closets with moveable receptacles.

The Nottingham pail-closet is, in reality, a closet with moveable middenstead. It constitutes the link between the pail-closet system and the midden system, and while finding a place in both systems is most usefully considered here. The Nottingham pail-closet, in fact, combines the advantages of the pail-closet with the simplicity of the midden-closet. The substitution of the pail for the middenstead at once obviates the various structural difficulties which beset the building of a middenstead so as to prevent its unwholesomeness, and permits that effectual removal of the contents and cleansing of the receptacle which attach to the pail system.

The closet is of the same simple construction as the Hull midden-closet, but the floor on which the receptacle stands is flat. The seat is hinged and the front moveable. The pail used beneath the seat is formed, as the pail used at Rochdale, of half a disused paraffin cask, and has an outside diameter of about 1 ft. 7½ in., and height of 1 ft. 3½ in. One pail only is used, all the ashes and dry refuse going into it. The used pail, covered by a metal lid, is removed weekly or at shorter intervals according to the necessity of the case, and a clean pail is substituted for it. An ordinary open waggon serves for the purpose of

removal and change, a tarpaulin being thrown over the pails. The used pail is carried to the depôt, emptied, washed, and then charged with a small quantity of a deodorant and antiseptic (freshly prepared carbolate of lime) for re-use.

The plan followed in certain parts of Edinburgh, in which the excrement, ashes, and dry house refuse are deposited in moveable receptacles of various forms in the houses, and then carried daily to the street for removal by the scavengers, might be considered a variety of the midden system and included in the category under consideration. But this plan, as the result of a peculiar local necessity, is unconnected with any structural arrangement for privacy, and although it may be regarded as belonging to this system, it is, perhaps, more accurately classed apart.

Pail System.

Pail system.

The pail system was observed in the following forms :—

(*a.*) *Pails used without preparation* (Glasgow).
(*b.*) *Pails supplied with a deodorant and antiseptic* (Rochdale, Birmingham, Nottingham, Leeds).
(*c.*) *Pails lined on the Goux system* (Halifax).
(*d.*) *Pails in which ashes and house refuse as well as excrement are deposited* (Edinburgh, Nottingham).
(*e.*) *Pails into which fine coal ashes are screened above the excrement* (Manchester, Salford, Cockermouth).

Pail.

1. As to the *pail.*—Two pails are used for each closet in the pail system as fullest developed, one for the reception of the excrement, the other for ashes and house refuse.

For excrement.

The *excrement pail* in ordinary use is either a wooden pail, such as that adopted in Rochdale, Nottingham, and Halifax, or a metal pail, such as that used in Manchester, Leeds, and Glasgow. In the more recent adoptions of the pail system the metal pail appears to be most approved, but the long experience of Rochdale is in favour of the wooden pail for domestic use. A metal pail is used in that town for factories only, and it is said to be more apt to get out of order, and to have a tendency to corrode at the bottom. Wooden bottoms, are, in fact, being substituted for the metal bottoms here, when these pails need repairing.

Angular wooden boxes, which were at one time used in Leeds, are found objectionable, from the difficulty of cleansing them. The Rochdale excrement pail has a capacity of 10 gallons ;* and it is undesirable, on account of handiness as well as on account of capacity, that pails of larger size should be used.

For ashes.

The *ash-pail* in Rochdale is a wooden pail of somewhat larger capacity than the excrement pail. In Manchester it is a rectangular box of handy dimensions. Elsewhere other forms of pail or tub are used. In Glasgow, an ash-pit is attached to the closet. A fixed ash-pit necessarily leads to much of the evil peculiar to the middenstead, for the contents of chamber utensils are liable to be thrown into it. This evil is not found to arise to any considerable extent with moveable ash receptacles. The nature of the receptacle acts as a check upon the practice, and the frequent removal of the contents enables a supervision to be maintained over it which operates very beneficially in preventing wilful carelessness or misuse.

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* The Rochdale pail, if filled, will hold 100 lbs. of excrement and urine as usually passed at stool ; the average weight of the contents of a pail, after one week's ordinary use by a household, is 41 lbs.

2. As to the *closet.*—The arrangement and structure of the closet is very much the same as that which has been described as the best form of midden-closet, the floor being in this case made level for the reception of the pails, both pails in the most satisfactory form of closet being included under the same roof. It would be difficult to suggest any great improvement upon the patterns adopted in Rochdale, Manchester, and Halifax. The compactness of the arrangement, and the facility with which the pail-closet can be adapted to the varied requirements of old towns in the reconstruction of midden-closets is most instructively shown in the plans given of adaptations in Halifax.

Closet.

3. As to *preparation of the excrement-pail.*—Thorough cleansing of the pail before use, and after each removal of contents, is necessary to the satisfactory working of the system; and dosing the cleansed pail before being placed in the closet with a deodorant and antiseptic (crude chloralum, as at Rochdale, or carbolate of lime, as at Nottingham) appears to act beneficially in retarding decomposition of the excrement and abating smell. The practice in Glasgow of simply tilting the contents of the pail into the scavengers' carts and returning the pail to the closet without scraping or brushing out the interior is bad, and the uncleansed pails are foul themselves, and augment foulness of the new contents by accelerating change in the excrement. Much importance is not to be attached to the lining of the pail, as regards absorbency, in the application of the Goux system to a mixed population; but the contents of the pails thus lined, as observed in Halifax, were less offensive to the eye than the contents of non-lined pails, and as little odorous, while the lining appeared to interpose some obstacle to splashing of the contents when the pail was used, and it afforded a ready and excellent cover to them when broken down either before or during removal.

Preparation of excrement pail.

The form of *lid* for covering the excrement pail during removal is not unimportant, and in this regard the Rochdale form as the result of longer observation and experience may be referred to.

Lid.

The *ash-pail* is simply emptied into the dust-cart, and needs no special preparation. But it is desirable that in those occasional cases where moist matters or slops have found their way into it, that the pails should have the "fur" which then collects on the interior surface scraped off. The dustmen should be provided with scrapers for the purpose, and be instructed to use them.

Ash-pail.

4. As to *working of the pail system.*—The *moveableness* of the pails is their great recommendation. If they were as a rule simply emptied into carts and replaced, the process would be quicker and infinitely less offensive than that of cleansing a middenstead of the old construction. But incomparably better than thus emptying them is the Rochdale, Manchester, Birmingham, and Nottingham plan of removing the tub with its contents, and substituting a fresh one. Nothing indeed can be better in this respect than the arrangements at Rochdale, which have formed the chief pattern upon which other towns adopting the system have acted. The full pail is covered by a tight-fitting lid, and the whole is carried off to the manure depôt in a properly constructed closed van; a fresh, clean pail, charged with a deodorant, and brought by the van, being placed under the closet seat, in lieu of the pail removed. Thus, without any offence, the excrement is gone. At the same time the contents of the ash-tub are tilted into a special cart, so that all the solid household refuse is removed together. Without approving the removal of excrement through houses, it may be observed, that on this plan it would appear possible that such transit can be made without notable offence.

Working of pail system.

The facility which the pail-system gives for *frequent thorough removal* is enormous. At Rochdale weekly emptying is the rule, but

many tubs are emptied two or three times a week. Other towns adopting a similar system have followed the same rule. Hitherto this removal has been effected during the ordinary working hours of the day, and the abomination of night scavenging to this extent got rid of. Obviously such frequent scavenging of middensteads could not be carried on at these hours without giving rise to incessant offence. Excrement collected by itself, or in combination only with ashes, ought not to be left in the vicinity of houses for a single unnecessary hour, and the plan of moveable pails permits of removal being effected more frequently than any other system in use in this country except waterclosets. Moreover, antiseptic agents can be very effectually applied under the pail system if special circumstances should cause them to be needed.

In this connexion it is impossible not to be struck with the advantage that a pail-system has in relation to diseased excrement. The facility and thoroughness with which any required chemical disinfection can be done, and the way in which the excrement itself can be wholly got rid of, leaving none of its products behind—nothing soaking into the ground or hanging about midden pits or sewers—obviously suggest most important powers possessed by this system for preventing the spread of excremental diseases.

5. As to *special adaptations of system.*—In Manchester and Salford a dry-ash system of excrement-disposal has been combined with a pail-system. Attached to the closet are arrangements by which ashes can be readily sifted, the fine ash falling by means of a shoot into the excrement tubs and covering the excrement, the cinders dropping into a receptacle whence they can be taken for reburning. The fine ash covering the excrement acts as a deodorant, and facilitates its subsequent manufacture into manure.

6. As to *general results.*—The pail system not only effectually does away with midden-nuisance, but, as carried out in Rochdale and Manchester, it is the only one which, while utilizing profitably all solid domestic refuse, appears to give promise of paying ultimately for the expense of its working.

The Water System.

Water system.

It is assumed here that the fundamental principles of the watercloset system are known, and so much of this system only has been included in this inquiry as would elucidate difficulties experienced in its application to certain classes of population. These difficulties are of two classes. The first class includes such as were described by Dr. Buchanan and myself in our report of 1869, as existing in London and other large towns, and which represent the difficulties attaching to the system when seen in its complete arrangements with water provided for every closet. The second class include the difficulties experienced in those towns and villages where waterclosets have been adopted, the supply of water to which has to be furnished by hand.

The first class of difficulties were thus summarised in the report of 1869:

> "A shoot or fragile pan, professing to be trapped, but with the trap almost certainly choked up, or knocked to pieces by the implement that has been used to get rid of obstruction; supplied, if in good order, with water by trickling from a small tap, but the tap usually either fixed or leaking wastefully all day long; no water in time of frost; almost universally filthy and stinking; and washed out (in a fashion to render the place unusable for hours) only every few days when the sanitary inspector is discovered to be in the neighbourhood."

The second class of difficulties, disclosed during inquiries into local

prevalences of enteric fever, consist of the insufficient flushing of the closet, and the blocking of the drains with excremental matter.

Two forms of watercloset have been devised to overcome the first class of difficulties, the *Liverpool Trough Closet*, and the *Tumbler Closet*; and a particular form of "eject," called the "*Bristol Eject*," is in use to obviate the latter class.

Liverpool trough closet.

The Liverpool *trough closet* was described in the report for 1869, as admirable in arrangement and working. The five years' additional experience of its operation confirms in every respect the opinion then formed of its perfect adaptability to the wants of a poor population. The closets are cleansed daily by the people using them according to a systematic rota; there is no waste of water, no injury from frost, and the whole of their machinery is worked regularly by the public scavenger. In addition to these advantages the wear and tear, owing to efficient original construction, has been remarkably small.

Tumbler closet.

The automatic action of the *tumbler closet* was designed to secure the regular flushing of the closet at arranged intervals independently of the persons using it. The conception is excellent, the application in practice has been most unfortunate. Local authorities and private individuals have alike contributed to frustrate the success of the closet, the latter by arrangements preposterously ill-adapted, the former by permitting the regulation of the water supply to be governed by considerations of economy, not always consistent with the sanitary object for which the closet was constructed. The tumbler closet appears to be capable of doing good work if due supervision of its action by the local authority and a proper supply of water can be obtained. An admirable report of the working of this form of closet in Birkenhead, by Mr. Francis Vacher, the medical officer of health, with the lessons to be deduced therefrom, is given elsewhere in this report.

Bristol eject.

The *Bristol eject* is a capacious and strongly constructed dip trap interposed between the privy "trunk," as the receptacle is termed, and the drain. This trap admits of the ready extraction from it of foreign matters cast into the privy, and from the strength of its construction it is not easily broken by efforts made to free it from obstruction. In this respect it has an important advantage over the waterclosets in ordinary use, but its successful operation among the poorer classes of Bristol depends, not upon this structural adaptation or on an abundant handy water supply, but upon the fact that the Corporation, through its servants, undertakes the responsibility of removing obstructions and seeing to its proper flushing among such sections of the population as are known from experience to be untrustworthy in these matters.

The Earth System.

Earth system.

The previous systems refer solely to the storage and removal, or to the removal alone, of excrement; and such dosing with chemicals or covering up with ashes and dry refuse as the excrement may have been submitted to, has been designed merely to diminish offence from it pending removal. The dry-earth system of excrement-disposal differs materially from the foregoing systems in this, that the earth, if used in sufficient quantity, while acting as an efficient deodorant, at the same time destroys the excrement as such, producing a uniform, inodorous, inoffensive, earthy mass. In this state, judging from the sight and the smell, it might seem as if the removal of the mixed earth and excrement from the vicinity of dwellings could with safety be greatly prolonged and the cost of such removal proportionately economised. In our present state

of knowledge of this compost and of the precise mode of origin of diseases connected with excrement, such a conclusion would be premature, and for the present at least, the same principles should apply to the removal of the mixed earth and excrement from the vicinity of houses as apply to mixed ashes and excrement or to excrement alone. On the other hand, in respect to storage, the dry-earth system yields advantages of the greatest importance in dealing with excrement in isolated dwellings and scattered communities in rural districts where accumulation is not to be avoided.

As a means of abating excrement nuisance, the dry-earth system is of the utmost value. Not every kind of earth is applicable to the system. Clayey and loamy soils and surface mould are best; chalk is of little use; gravel and sand are worthless. Conditions of its proper application are that the earth, thoroughly dried and not too powdery, shall be applied in detail to each stool in quantities of not less than $1\frac{1}{2}$ lb. This application may be made simply by a scoop, or by any of the various forms of mechanism which have approximated the earth-closet for convenience and cleanliness of use to the watercloset. Preferably the receptacle for the mixed earth and excrement should be moveable. Fixed receptacles should be constructed in accordance with the general principles laid down in regard to middensteads.

Important evidence of the facility with which the dry-earth system may be carried out in practice, and of its efficiency in the abatement of excrement nuisance, is afforded by the numerous instances in which persons accustomed to waterclosets have voluntarily substituted for them this system.

The Charcoal System.

The successful introduction of charcoal as a common means of abating excrement nuisance would be a gain of which it is not possible as yet to estimate the proper value. Hitherto the use of this great deodorant for the ordinary needs of a community as to excrement disposal has been precluded by its costliness. By the fabrication of charcoal from seaweed, and (as is stated) from street-sweepings, it would appear probable that charcoal may presently be put in the market at a price admitting of its being largely applied by sanitary authorities and others to sanitary uses. By the further proposition of Mr. Stanford to convert the excrement itself into charcoal, and to utilize it (in addition to other profitable utilizations) in abating nuisance from itself, a further important gain would be obtained in overcoming the difficulties of excrement-disposal, if the proposition should prove successful in practice.

Charcoal, as used for the abatement of excrement-nuisance, requires to be applied in detail after the manner of dry earth, and with similar mechanisms; but a much less quantity of the material is needed for the purpose (one fourth, so stated). It is claimed for the mixed charcoal and excrement that it need not be removed from the receptacle more than once in twelve months; but the same observations apply here as have been made in respect to mixed earth and excrement. The claim is made upon a presumption which has no present substantial foundation; and the use of the system among a community should be governed by the same principles as govern other systems of removing excrement by cartage.

III.—Liquid House-Refuse.—Slops.

Slops.

The question of abatement of nuisance from liquid house refuse, in those cases where, as in isolated houses and small hamlets, it is not

found practicable to deal with it under the conditions applicable to sewerage in general, has been considered in the course of this inquiry. Several instructive and largely applicable modes of abating nuisance under these circumstances, all by securing the efficient utilization or inoffensive disposition of the refuse on land, have come under observation, and are detailed in the report.

IV.—Excrement-Disposal in Rural Districts.

Excrement Disposal in Rural Districts.

It is desirable that the application of some of the foregoing observations to certain of the requirements of rural districts should be more particularly indicated. Where a community of arrangements is practicable to the local authority there the same principles apply in the general provision of means for excrement-disposal, whatever the size of the place, whether hamlet, or village, or town. But there are numerous scattered communities, and scattered groups of dwellings, and isolated houses and cottages which cannot be brought within any common local scheme of arrangements for excrement-disposal. Also, there are numerous communities which, although living together in a space sufficiently compact for a general scheme, have belonging to them many houses with gardens or other cultivated land for which it is desired, and indeed, requisite to retain the whole of the excremental refuse of the household for manure, and for which the regulations of the local authority should make provision. In all such cases no hard and fast scheme of excrement disposal is practicable or advisable, and general success is probably only to be obtained by the application in detail of several schemes according to the particular requirements of individual houses and groups of houses, and the particular proclivities of their occupiers. My own experience tends wholly to prove that a more assured advance is obtained in the cases here contemplated by making existing and familiar local arrangements for excrement-disposal harmless, than by introducing novel arrangements. From this point of view there is no lack of means at the disposal of local authorities. If the predilection be in favour of the common privy, the Glasgow pattern (p. 162) suggests a means of diminishing its evils. Better still, Mr. Neville-Grenville has shown at Butleigh (p. 166) that it is quite practicable by a transformation of the common privy, of the simplest character, to make it an effectual and inoffensive dry-ash or dry-earth closet; and Dr. C. E. Saunders, has adopted at Tring (p. 170), a modification, hardly less simple for the same purpose. Again, Mr. Fox, at Cockermouth (p. 193), finds that it is possible to obtain the benefits of a pail system among certain classes of the rural population, irrespective of the local authority undertaking its management; and the Nottingham moveable middenstead suggests an adaptation of the pail system to rural life which must be obvious. Excellent illustrations of the advantage of such a form of middenstead I saw in operation in one instance among the fishing population of Mousehole, near Penzance, and in other instances among the agricultural population of Paul Church Town, also near Penzance. The dry-ash closets, designed by Dr. Francis T. Bond (p. 167), the simple dry-ash arrangement of Mr. Fox, and the still simpler arrangement of Mr. Neville-Grenville, are examples of a mode of excrement-disposal of which the applicability is only now being tested. Again the dry-earth system furnishes another important and extensively applicable means.

The different modes of excrement-disposal here suggested will very largely meet local needs, and the principles upon which they are founded admit of great variety in application. Ingenuity is not yet exhausted in devising methods for preventing deposited excrement fouling either the soil or the atmosphere, or from being offensive either to the sight or the smell; and local ingenuity should be exercised in planning the means of meeting these requirements for local wants. But no

amount of ingenuity will obviate the necessity for supervision on the part of the sanitary authority; and any plan will, as a rule, certainly fail if care be not taken, in the first instance, to secure its proper application and to familiarize its use.

Excrement Disposal in Rural Districts.

Suggestions for abating nuisance from liquid house-refuse in rural districts, the complement of the abatement of excrement nuisance, are given in the report (p. 229).

V.—Summary of Conclusions.

The general conclusions which I have to submit as resulting from this inquiry, are the same as those submitted by Dr. Buchanan and myself in 1869, modified only in phraseology to meet certain modifications of details:

1. Excrement may be removed from a town or village and disposed of on more than one principle, and the same principle does not need to be applied in all quarters of the same place.

2. As regards the parts of a town or village inhabited by the poorer classes, a watercloset system may be managed so as to be entirely applicable to the circumstances of the most ignorant and most careless population. Essential conditions of such applicability, however, are that the structural arrangements should be adapted to their purpose, and that the management should be wholly undertaken and efficiently done by the servants of the sanitary authority. Where these conditions are observed as thoroughly as they are observed in parts of Liverpool and Bristol, waterclosets are the best means of removing excremental matters from the poor neighbourhoods of a town.

3. The dry-earth system affords a second way of safely disposing of excrement. It is an essential element in this system also, as applied in poor neighbourhoods, that the entire management of it shall be conducted by the sanitary authority.

4. The charcoal system affords a third way of safely disposing of excrement, subject to the same condition of management by the sanitary authority in its application to poor neighbourhoods as the dry-earth system.

4. The midden system may be modified so as greatly to reduce nuisance and danger from it. The forms of midden-closet have been described which present fewest objections. Satisfactory safety in the use of even these forms of midden-closet cannot be averred with certainty, partly because there is no near prospect of such closets being emptied daily, and partly because the materials of the middenstead would probably be retentive of some excremental matters. But if, under certain circumstances, midden-closets constructed as above should be tolerated, it would be scarcely less than essential, first, that they should, if in a densely populated neighbourhood, be emptied daily, or under other circumstances at least once a week, and secondly, that the arrangements for excrement-removal should be wholly in the hands of efficient persons appointed by the sanitary authority.

5. The pail system presents several advantages for poor town districts. This system involves forms of construction or constructive alterations similar to those required for the toleration of a midden system, and offers peculiar advantages over the latter in regard to facility for frequent removal of excrement and to completeness of such removal, in regard to safety from nuisance, and probably in regard to profit in disposing of excrement as manure. The pails, of defined construction, should be changed daily for fresh ones in all crowded neighbourhoods and when used by several families in common or by numerous individuals, and under no circumstances should they remain unchanged more than one week. It is essential to the proper working of a pail-

system that it should be carried out in towns and villages by the sanitary authority.

6. Those who use the closet may, both under the pail and the midden system, be expected, with due superintendence, to do the cleansing of it so far as merely affects ordinary comfort and decency ; but such action as concerns the effectiveness of the closet as a means of excrement-removal must be taken by the sanitary authority itself.

7. If these conclusions be accepted, it follows that there are various methods which will fairly answer the purpose of preventing nuisance and injury to health from the retention of excrement near dwellings.

B.—Detailed Report.

I.—Towns and Villages Visited and Reported on.

(*a*) *Alphabetically arranged.*

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(*b.*) *Classified with reference to the particular object for which visited ; the typical examples being given first in each class :*

1. *As to Excrement Disposal without Closets :*

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2. *As to Middenstead and Dry-Ash Closets :*

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3. *As to Pail-Closets :*

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4. *As to certain kinds of Water-closets :*

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5. *As to Earth-Closets :*

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6. *As to Charcoal-Closets :*

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7. *As to Slop Nuisance :*

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On Excrement Nuisances, by Mr. J. Netten Radcliffe.

Excrement Disposal by Cartage.

1. *Excrement Disposal without Closet.*

Edinburgh.

Edinburgh.—In Edinburgh the cleansing operations of the Corporation are designed to compass a daily removal of all filth. With regard to excrement disposal, this, in 1873, was provided for in 27,294 of the 41,615 houses* in the burgh by waterclosets, and in the remaining 14,319 houses by the scavenger. These latter houses include the tenements* of old Edinburgh, of which the common stair with the numerous apartments or suites of apartments opening upon it, occupied by separate families, may be compared to a blind court with its closeness and darkness exaggerated to the utmost. In these tenements, partly from their structure and partly from the class of people occupying them, it has been found impracticable to introduce waterclosets or other fixed method for disposing of excremental matters; and these matters as well as the dry household refuse of the tenements are systematically removed by the scavengers. The manner in which this is effected is similar to that which is enforced for dry household refuse of all kinds. "Dust carts," so called, traverse the streets of the burgh in regular beats at stated times every morning except Sundays, beginning their rounds at 6 a.m. or 7 a.m. according to the period of the year. The house refuse is removed from the new town during the first hour the carts are on duty, and from the old town during the second hour. Householders are required to take "every offensive matter" to the streets or courts "in "pails or buckets, or other proper vessels, before the time of passing of "the dust cart for deposit in it, under a penalty of 40*s.* for neglect of "this duty." In the new town the "offensive matter" removed consists of the ashes and ordinary day refuse of a household; in the old town it includes largely excrement also. The vessels containing simple household refuse are, as commonly obtains in the new town, placed on the edge of the footway and are emptied by the scavengers directly into the dust cart; the vessels containing excrement and house refuse, as largely obtains in the old town, are first emptied into the channel by the persons to whom they belong, forming more or less offensive heaps which are shovelled by the scavenger into the dust cart. This difference in practice appears to be necessary in order to secure a proper return of the vessels, in the latter case, to their respective owners, and to prevent confusion of ownership; the police regulations requiring that these vessels be removed within 15 minutes after the dust cart has passed, under a penalty not exceeding 10*s.* for neglect.

The vessels used for both excrement and house refuse, and which do not appear to receive any other cleansing than the daily emptying, are of necessity kept by their possessors in the passage to their rooms, or in a closet, or even in the living or sleeping room.

The scavengers commence their work an hour before the dust carts commence their rounds to prepare for them, and they continue at work with one hour's interval until 4 p.m. Scavengers with barrows follow the dust carts to remove any scattered refuse which may have been left, and this is deposited in fixed dustbins until the carts next pass. Freshly slaked lime is freely sprinkled wherever filth has been deposited in the streets, courts, and thoroughfares. Twice in the week, on the evenings of Friday and Saturday, a supplementary round is made by the

* The words houses and tenements are here used in the Scottish sense; the *house* meaning a dwelling of one or more apartments, entered by a separate door from the street, court, lane, or common stair; the *tenement*, a separate building standing by itself, or divided from others by a wall from basement to roof.

dust carts in certain streets of the old town, beginning at 9 o'clock, and the scavengers accompanying the carts are on duty one hour. Formerly this supplementary scavenging was carried out five evenings in the week, but in consequence of recent great increase in the wages of the carters it has been found advisable to diminish the number of evening cleansings. On Sunday the scavengers are on duty from 6 a.m. to 9 a.m.

The provision for excrement disposal among the tenement houses in the old town above described, is supplemented by public privies. These are 25 in number, all adapted for several persons, and some forming considerable blocks of building, with numerous seats. The greater number of these are MacFarlane's trough latrines, used without water; some are simple pail closets; and others, also pail closets, are arranged to be worked on the dry-earth system, and are now worked provisionally with dry ashes (see *Plates* I. II. III. IV.). Six blocks of privies have been fitted up on this latter plan, the scavenger of the locality in which they are placed being made responsible for their due working. The mechanism for casting the ashes or earth from the hopper upon the excrement is arranged to be worked only from the scavenger's passage in the privy, and he is expected to visit the privy three or four times daily to put the mechanism in action. This duty, however, did not appear to be well carried out; and it is probable that its efficient execution will not be ensured until one or more persons are specially appointed to attend to it. The contents of all the public privies are removed daily; the value of the excrement in adding to the worth of the general town refuse as a manure being held as a sufficient set off for their somewhat complicated arrangement and working as compared with water latrines.

The quantity of refuse carted to the depôts in 1873 was 56,000 tons, averaging a little over 150 tons daily. At a depôt on the canal, which I visited, the refuse is at once tilted into barges, and these when filled are forthwith sent into the country. At another depôt, which I did not think it necessary to visit, the refuse is stored until required by farmers. The selling price of the refuse at the time of my visit, and after it had been enriched by the refuse from the slaughter-houses and markets (which are cleansed under special regulations) and the contents of the public privies (removed daily) was 2*s.* 6*d.* per ton.

When Dr. Buchanan and I visited Edinburgh in 1869, the scavenging of the burgh was done under contract. Now the Corporation has undertaken this work itself with, it is stated, great gain both in the efficiency and economy of the work. A saving of 2,800*l.* was effected upon the cost of scavenging in 1873 as compared with 1871, the work being done better and with a smaller number of horses.

The scavenging staff and plant of the burgh are as follows:—*Staff:* 1 inspector, 1 assistant inspector, 1 general overseer, 7 district overseers, 136 scavengers, 4 depôt men, 3 cartwrights, 1 blacksmith, 2 tinsmiths, 3 shoeing smiths, 2 foremen, 2 stable men, 68 carters. *Horses*, 68. *Plant:* 36 waggons, 40 carts, 10 ordure carts, 18 water carts. Each carter is supplied with a wheelbarrow, shovel, &c., and a weekly supply of brooms. The cost of cleansing and watering the burgh for the year ending Whit-Sunday, 1873, was 21,605*l.*, less 5,493*l.* obtained by the sale of manure = 16,142*l.*

No other plan probably than the plan of scavenging which has been here described, would meet the peculiar difficulties which have to be contended with in the tenements, and amidst the narrow wynds and closes of old Edinburgh and the class of population which inhabits them, and reduce the evils arising from accumulated filth there to the least practicable limits. The more closely the cleansing arrangements and opera-

Edinburgh.

tions of Edinburgh are studied on the spot, the more forcibly is the mind impressed with the facility of dealing with common filth by systematic scavenging. The conditions, however, which determine the peculiar filthiness of parts of Edinburgh, and which have given to this filthiness historical notoriety, are happily becoming things of the past. The Corporation has entered upon and is rapidly pushing forward on the only course which will remove from Edinburgh the sanitary disadvantages under which it has so long suffered. Broad new thoroughfares are being opened out through the oldest, densest, and worst quarters of the old town, and those older tenements which have prolonged the filth and unwholesomeness of the middle ages into the 19th century, and had superadded to them the squalidness and misery of our own time, are being pulled down unsparingly. The changes which have already been effected by these clearances in the aspect of many historical wynds and closes of the old town is indescribable; and the new Old Town which is rapidly growing up in place of the old Old Town retains all the wonderful picturesqueness of that town that deserves to be retained, and will eventually add to it, while keeping little or none of its unwholesomeness. In the new tenements which have been erected waterclosets have been introduced, and in subsequent buildings the watercloset system of excrement disposal will be adhered to. But for some time to come the old tenements of the city will have to be dealt with each upon its own merits as respects such disposal, and no uniform system will be practicable.

2. *Excrement Disposal by Midden Closets and Dry-Earth Closets.*

Hull.

Hull.—Hull retains unchanged the peculiar system of excrement disposal described by Dr. Buchanan and myself in 1869. This system, supplemented in the better classes of houses by waterclosets, is now in general use throughout the borough. It rests upon a certain frequency of scavenging, the common privy being so modified in size of receptacle that it will not admit of a greater collection of excrement and dry-house refuse than that which accumulates in the intervals of the scavengers' call, and in structure that rain is excluded and soakage into the ground prevented.

For the purpose of "nightsoil collection" the borough is divided into 48 districts, each containing from 300 to 700 houses, the total number of houses enumerated for the purposes of this collection in 1873 being 30,977. The collection is carried out by the sanitary authority through the agency of contractors. As a rule each district is let out to a separate contractor, and no contractor is allowed to undertake more than two districts. The smaller districts are so arranged that the collection may be carried out by anyone who has the command of a horse and cart, and who can have the assistance of a boy or two. With a view of obviating undue combination among the contractors, and diminishing the evil effects of strikes among the men, the contracts are so timed in the letting that only 8 or 9 can fall vacant together. The contractor, in addition to receiving the material he collects, and which he sells for such profit as he can obtain, is paid by the sanitary authority from 2*s.* to 3*s.* yearly for each house in his district.* The sanitary authority provides places of deposit (four in number) where the contractor can store the collected material until disposed of; and he is subject to penalty if he should deposit such material elsewhere without permission of the inspector of nuisances in writing.

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* In 1869 this payment was from 1*s.* to 1*s.* 6*d.*

The contractor is required by the terms of his contract to collect and remove, *at least once a week*, all nightsoil, offal, dry and liquid filth, dust, paper, and other refuse of every description from all premises, middensteads, ash pits, dust boxes, cellars, or other places used for such refuse, attached to all houses, shops, warehouses, yards, and other premises within his district, with the exception of trade refuse exceeding in quantity three cubic feet in any one week, and all contents of cess-pools, blood, manure, and filth from slaughter-houses, ashes from furnaces, and refuse from manufacturing processes. The work of collection and removal is to be executed on week days, from the beginning of March to the end of October between the hours of 5 and 8.30 a.m, and from the beginning of November to the end of February, between the hours of 6 and 9.30 a.m., and all carts employed in the work are to be clear of the streets and public thoroughfares, on their way to the depôts, before 9 a.m, within the former period and before 10 a.m. within the latter period. Further the contractor is required to use water-tight and properly covered carts.

In practice, while the weekly removal of excrement and dry-house refuse from the different houses in the borough is very generally secured, certain irregularities of collection are occasioned by the early hours at which the collection commences. Many families at this hour have not left their beds, and the scavenger is unable to obtain access to their premises. In these cases the families will not disturb themselves to admit the scavenger until their receptacles are full, but in regard to privies these from their construction rarely admit of more than a fortnight's accumulation of excrement and house refuse. The requirement of the contract as to water-tight and covered carts is not carried out, and the contractors are permitted to use the common open cart. It has not been found practicable to insist upon this requirement with numerous small contractors.

Consistently with the design of this plan of scavenging, and as part of the scheme it involved of preventing the accumulation of refuse matters on any premises for longer periods than one week, the common privy has been modified in arrangement, so that the pit will not hold more than a week's collection of excrement and dry house refuse. Its construction is also so altered that wetness of contents is intended to be avoided, and if wetness happens, soakage into the soil prevented.

The arrangement of this privy is shown in Plate V. The space under the seat forms the entire receptacle for all the ashes, refuse, and excrement of the house, and is built of bricks in cement, with a bottom of brick or flag, sloping from the level of the paved floor in front to a little below the ground level at the back, and forming only a very shallow pit. Into this space, through the hole in the privy seat, all dry refuse is thrown. The front of the midden space is formed by the front board of the closet, which is made moveable to give the scavenger access to the pit. There is no drain to it, as rain is excluded and slops are in practice thrown down the drains. The ashes are usually sufficient in quantity to soak up all moisture passing into the pit, and the contents are almost invariably dry, and are removed by a spade without difficulty.

The cost of erecting a privy of this construction is 3*l.*, and when built in a corner against existing walls, 2*l.* 10*s.* Every new house, if it have not a watercloset, is required to have a privy of the construction described ; and at the back of every new house there must be a space of the full width of the house, and not less than 8 feet long. Upon this space only the pantry, coal-house, and privy may be placed, the privy being farthest from the house. In this way an open yard space is secured of not less than 60 or 70 square feet (see Plate V.) It is an exception to have a back entrance to this yard, and the contents of the

privies when removed, must, as a common rule, be carried through the house. Little offence appears to be occasioned by this objectionable arrangement, and such rare complaint as came to my knowledge referred to careless scattering by the scavenger of ashes from the bucket or other vessel in which the contents of the privy were removed to the cart.

An extended examination of privies of the kind here described, and of the manner of cleansing them, confirmed the opinion formed by Dr. Buchanan and myself with regard to them in 1869. They represent an enormous gain upon the old form of privy for which they have been substituted, both as to freedom from, and as to liability to, nuisance. In the greater number of instances inspected the excrement, even in families having young children, was as a rule well covered with ashes, and the freedom from privy smell was remarkable; and this although I had inspected on days fixed for removal of the refuse (the seventh day of accumulation), or, sometimes, in cases specially sought out, when the removal had been delayed for longer periods. The contents of the privy were dry, and their disturbance by the spade of the scavenger during removal gave rise to very little and at times to no offensive odour. In other instances privy stink was considerable, and this appeared to be determined by one or other of the following conditions :—

1. Deterioration, or original imperfect construction of the walls of the privy pit, leading to retention of portions, and perhaps to some soakage, of decomposing filth.

2. Careless casting of slops into the privy pit, facilitating decomposition of the contents and soakage of the woodwork.

3. Want of adaptation of the scavenging to the needs of particular localities and their inhabitants. In the localities occupied by the most impoverished and degraded of the population the privies were overflowing with filth, and most offensive. This arose mainly from the insufficiency of the scavenging. Designed to meet the requirements of a single family only, the Hull privy cannot be used by several families without being productive of nuisance, except on condition of a more frequent removal of its contents than once a week. A daily removal is necessary under these circumstances; and as to orderliness of the privy, in those cases where a single family cannot be made responsible for it, this will not as a rule be secured unless the sanitary authority itself undertakes the duty of maintaining it.

The collection of nightsoil and household refuse is not carried out with the same efficiency in all the collecting districts. From the impracticability of exercising thorough control over the numerous contractors, the regulations for their guidance are not as carefully observed as they might be. Forty-two fines were inflicted in 1873 for gross neglect of duty on the part of the contractors; and the inspector of nuisances in his report for that year observes of some of the contractors, who do not employ suitable men, and whose horses and carts are not good, that they are "a cause of many complaints by the public," and a source of annoyance to the sanitary committee. The medical officer of health for the borough, Mr. J. Fearne Holden, in his report for the same year, expresses the opinion that the "collection of nightsoil can only be efficiently effected by the (Local) "Board assuming the entire responsibility without the intervention "of contractors."

Glasgow.

Glasgow.—Three different methods of excrement disposal are in use in Glasgow, besides certain experimental methods. The methods in ordinary use are (1) waterclosets; (2) pail closets; and (3) middenclosets of various descriptions. These several methods are distributed

among the 100,000 houses in the parliamentary burgh in the following numbers: waterclosets, 31,927; pail closets, 4,365; midden closets, blocks of, 1,278.* What proportion of the half million population of the burgh uses each method is not accurately known; but, in evidence before the Rivers Pollution Commission in 1870, Mr. Carrick, the master of works, stated that about half the population used waterclosets. A pail, in a pailcloset, is considered to be necessary for every 10 families; a privy may serve for many more families, as in some of the instances which will presently be referred to. In one of these a privy serves for 59 families. This, however, is not considered adequate accommodation.

In Glasgow, as in Edinburgh, the tendency in new buildings is to

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* Parliamentary Burgh of Glasgow, 1872–3.

Return showing the Number of Houses, Manufactories, Shops, Warehouses, Drains, Ashpits, and Waterclosets, &c.

Number of dwelling houses			101,368
„ shops			8,874
„ warehouses and counting-houses			4,053
„ manufactories and workshops			3,291
„ stables			2,304
„ horses			7,024
„ cowhouses			311
„ cows			1,350
„ urinals drained into sewers			211
„ ashpits drained	5,288		
„ „ undrained	795		
			6,083
„ privies drained	935		
„ „ undrained	343		
			1,278
„ pans only			4,365
„ common sewers, lineal extent in yards			140,366
„ manufactories discharging organic refuse	55		
„ „ „ chemical „	54		
			109
„ waterclosets in houses of one apartment	454		
„ „ „ two apartments	5,702		
„ „ „ three „ and upwards	21,512		
„ „ „ in shops	1,709		
„ „ „ „ warehouses, counting-houses, &c.	2,550		
Total number of waterclosets in the city			31,927
Number of sinks in houses of one apartment	11,185		
„ „ „ two apartments	30,502		
„ „ „ three „ and upwards	29,604		
Total number of sinks in the city			71,291
„ fixed basins in dwelling houses			3,865
„ cisterns for W.C. and domestic supply	8,940		
„ „ „ only	14,957		
			23,897
„ houses supplied with water from mains	55,394		
„ „ „ „ cisterns	31,802		
			87,196
„ soil pipes, ventilated	17,701		
„ „ unventilated	14,522		
			32,223
„ cesspools			1,901
„ courts, paved	6,444		
„ „ drained	8,831		
			15,275
„ stairs and passages, ventilated			7,876
„ dwelling houses, lobbies			92,895

	1872	1873.
Estimated Population within Municipal Boundary	502,990	514,295

adopt waterclosets, and these are being more extensively introduced from year to year. The older tenements of Glasgow, as of Edinburgh, from their arrangement and the class of population inhabiting them, do not admit of the introduction of waterclosets. For these buildings and their inhabitants efforts are mainly directed to the improvement of previously established plans. I observed in some of the newer tenements which had been furnished with waterclosets that these were out of order and offensive. This had arisen from inability to make particular families in the common stair responsible for the cleanliness of the waterclosets, owing to the inconvenient position and insufficient number of the latter. In other instances, where each flat had its separate watercloset, and this was kept locked, the families of the flat being held responsible for its orderliness, the waterclosets were kept in excellent order, although imperfectly lighted from the common stair.

When Dr. Buchanan and I visited Glasgow in 1869, middensteads were to be seen attached both to public and private privies, of enormous size, filthy and fœtid, uncovered, receiving all urine as well as stools of the neighbourhood, and also ashes. Middensteads of this kind still exist, but probably all are now covered in. Of the 1,278 middensteads in the burgh, 935 are drained. For middensteads of this class there are now being substituted smaller, covered, undrained middensteads, of a capacity calculated to hold two days' accumulation of the filth, ashes, and dry-house refuse of the families using them. This important change, begun before 1869, has since been steadily carried out, and recently has received a further development, which makes the Glasgow midden closet, as newly designed—one detail alone excepted, —a pattern for the construction of the common privy, so long as common privies must be tolerated. The additional improvement consists in so fixing an inclined plane beneath the opening through which the ashes and dry-house refuse are thrown into the middenstead, that these shall fall above and cover the excrement. The exception referred to is that the bottom of the middenstead is sunk beneath the level of the ground, which should not be the case. Mr. Carrick, the master of works, appears to have been the first to have conceived this arrangement, but its successful working out has been due to Mr. Dobson, of the sanitary department. Plates VI. and VII. show the arrangements of this form of privy.* The following description of the plans, including also a description of a plan of pail closet (Plate VIII.) is furnished by the sanitary department :—

Description of Privies in the Central Sanitary District of Glasgow.

No. 1 (*Plate* VI.)—Is a combined ash-bin and privy, constructed with 9-inch brick walls, the seat, riser, inclined plane, bottom and roof of $1\frac{3}{4}$-inch Caithness stone. The whole structure covers an area of 56 superficial feet. This gives accommodation to 27 families, two warehouses, and seven shops, and costs 16*l*.

No. 2 (*Plate* VII.)—Is a design of two privies, placed back to back, and divided into four compartments by two partitions of Caithness stone, $2\frac{1}{2}$ inches thick; the external walls are built of 9-inch brickwork in mortar, the seat, riser, inclined planes, and bottom of bin of $2\frac{1}{2}$-inch Caithness stone set on one course of brick footings.

The dotted lines are suggestive of a screen to hide the persons sitting from persons passing. The superficial area on which it stands is 95 feet, and giving accommodation to three distinct localities, having a population of 236.

No. 3 (*Plate* VIII.) is the plan of a privy on the pan system, constructed with $1\frac{3}{4}$-inch Caithness paving stone set in grooves in the pavement of the court,

* Mr. Dobson has also devised an ingenious mechanical arrangement, the details of which are shown on Plate VIIa., having for object the prevention of annoyance, from ashes being cast into the middenstead when in use, to the persons using it. An experimental trial of this arrangement was being made when I visited Glasgow.

and cramped together with $1\frac{3}{8}$-inch × $\frac{3}{8}$-inch wrought iron angle irons, and $2\frac{1}{2}$ × $\frac{1}{2}$-inch screwed bolts and nuts jointed neatly with Portland cement. adapted for the accommodation of males, females, and children.

The seats are made of cast-iron with close-fitting galvanized iron pails underneath. The whole structure covers an area of 65 superficial feet, accommodating 59 families, and cost 16*l*.

The objection to this privy arises chiefly from the foul odour continually emitted from the coating of fæcal matter on pails, which could easily be obviated by substituting a clean, deodorised pail at each removal. [The contents of the pails are merely emptied into the scavengers' cart without other cleansing].

At the time of my inspection there was superabundant evidence in the central district, from overfull middensteads and ash-pits, that the operations of the sanitary department and of the scavenging department were not in proper accord. The scavenging of the middensteads and ash-pits has not kept pace with the work of the sanitary department in reducing their size, and as a consequence of the less capacity of these receptacles, they fill and overflow more rapidly than the scavenging department is prepared to deal with them. This want of accord between the two departments did not seem to me to rest upon any necessity of the case, but to arise chiefly from the vicious principle upon which the scavenging of the middensteads and ash-pits is carried out. Theoretically the central district of the town is scavenged every alternate night, and in practice the nightsoil carts traverse it for this purpose. If the scavenging were carried out systematically from street to street, privy to privy, and ash-pit to ash-pit, the present arrangements would suffice, no doubt, to obviate the nuisance from overflowing middensteads and ash-pits which came under my observation. But actually the scavenging is governed by the fullness or not of the middensteads and ash-pits, and this in a given locality is judged by the largest not the smallest. The same practice holds good in the scavenging at longer intervals of other districts of the city. The mode of payment of the scavengers directly fosters this practice, and holds out a premium for imperfect work in another important way. The scavengers are paid at so much per ton of the filth removed, and it is to their interest to encourage fulness of the receptacles so as to diminish the quantity of ground traversed in collecting the contents.* Another evil of this mode of payment is, as I had occasion to observe, that it affords an inducement to the men to cleanse the receptacles imperfectly, the walls not being scraped and the bottoms carefully swept out.

Plate VIII. gives a drawing of a pail closet in ordinary use for a court or common stair. The pails are galvanized iron cylindrical vessels, calculated each to serve for 10 families during the intervals of the scavengers' rounds. These pails, which receive excrement only, are simply emptied into the scavengers' cart, and are neither scraped nor otherwise cleansed. The whole of those I saw were encrusted with filth, and stank offensively, and Dr. Russell, the medical officer of health, has satisfied himself that the excremental matters received into them when in this state rapidly decompose.

The ash-pits, or more accurately middensteads, attached to these pail-closets also receive a considerable quantity of excremental matters from chamber-pots, which are freely used for defæcation in the tenements, and of which the contents are not uncommonly retained some time in the house.

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* "Under the present system the men work by the ton, and could not under the nightly system earn the same amount of wages, as they would require to travel over much more ground before they could collect the same quantity of material."—*Observations of the Inspector of Cleansing in reference to a Memorandum of the Medical Officer of Health on the system of cleansing ash-pits, pans, &c.*, 17*th July* 1873.

Dr. Russell has made the following suggestions as to the scavenging of middensteads and privy-pans :—

" 1st. Every midden receiving human excrement should be emptied daily, the only open question being whether in the winter season, when decomposition takes place more slowly, two or three days might elapse where the size and position of the midden will admit.

" 2nd. Every privy-pan should be emptied daily, and in confined localities, during the prevalence of specific diarrhœal disease, twice daily.

" Following these main propositions, and carrying out the principle into details, it may be added :—

" 1st. That after emptying a midden, the close, court, street, or other surface smeared with its contents should be carefully washed with the hose before the heat has converted the matter into dust, which, as well as the gases evolved, may be transported by the air.

" 2nd. Pains should be taken actually to empty the midden, and to scrape from its sides all adherent dirt.

" 3rd. The privy-pans should be not only emptied, but cleaned, so that they may not be replaced having a layer of fæcal matter over their sides exposing a large decomposing surface to the air, and ready to act like a ferment on the fresh excrement, rapidly propagating to it the process of decomposition.

" 4th. Another matter indirectly coming up for remark in this connexion is the removal from the roofs of privies, and other out-houses, of the organic matter thrown there from higher levels. The prevention and punishment of this offence is desirable, but meanwhile, and especially in hot weather, those decomposing matters ought to be removed."

Under existing arrangements, Glasgow for the purpose of scavenging is divided into six districts. The scavenging of the privies and ash-pits is carried out between the hours of 11 p.m. and 8 a.m., and the night staff consists of 65 carts and men with 60 emptiers. The quantity of stuff removed by this staff per week to the various depôts, 10 in number, is computed at 2,000 tons, where it commands a sale for manure at 1*s.* 6*d.* per ton. The entire cost of the scavenging department for the year 1872–73 was 46,275*l.* 0*s.* 0*d.* with a set-off for sale of manure and other items of 17,493*l.* 0*s.* 0*d.* The sale of manure for the year had produced 17,987*l.* 0*s.* 0*d.*; the receipts for manure, including outstanding sums for the preceding year, were 17,375*l.* The scavenging is done by the Corporation, and here, as in Edinburgh, the statement is made very positively that the Corporation to secure the same degree of efficiency does the work with its own staff and plant at a less cost than it could be done by contract.

Two experimental methods of excrement disposal came under observation in Glasgow, one a modification of the watercloset system (*Hoey's watercloset*) ; the other a system in which charcoal is used to deodorize the excrement and facilitate its ulterior use. This last-named method I have had to examine elsewhere than in Glasgow, and the illustrations of its operations I observed in this city I have included in the separate description which I have given of the method.

Hoey's watercloset is designed to limit to the smallest amount consistent with efficiency the quantity of water used in flushing the pan, and to prevent the passage of the excrement into the sewers. An ingenious arrangement in the cistern restricts the flush of water to a fifth of a gallon, and the excrement is received into an iron tank beneath the floor of the building. By diminishing the amount of the water with the excrement a manure of commercial value sufficient to cover the cost of this arrangement is believed to be obtained ; by keeping the excrement from the sewers the dangers commonly arising from sewer air are supposed to be avoided. The tank when full is emptied by atmospheric pressure into an exhausted wheeled

receptacle. I examined this arrangement as applied to four closets in tenement No. 243, Stirling Road. In each closet on raising the handle there was a mere dribble of water, in quantity quite insufficient to remove freely and fully an ordinary stool, especially with paper, and the closets had to be flushed from time to time with a bucket of slops or of water. Each closet pan, although the closets were locked and under the care of orderly people, was more or less smeared with excrement. The excrement tank is a cesspool, and the protection from it on the house side, supposed to be obtained (if the arrangement be adopted, which was not the case so far I understood at No. 243 Stirling Road) by a disinfecting cistern, which suffers a charge of a disinfectant to pass into the soil pipe with each use of the closet, is simply fallacious. Even more fallacious is the supposition that the tank intercepts the passage of the whole of the excrement into the sewers. The tank has an overflow, and there was no certainty in the instance under observation that the overflow was not in frequent action. The tank, in fact, is a mere catch-pit interposed between the soil pipes and the sewers. The whole arrangement is such as to demand for its reasonable working an amount of supervision rarely possible to obtain; and the advantages claimed for it in saving water and securing a saleable manure appear to me to be gained at the cost of more important considerations.

Note.—Through the kindness of Dr. A. Fergus, I had an opportunity of examining during my visit to Glasgow several examples of corroded and perforated soil pipes. Dr. Fergus discovered these perforations in soil pipes a few years ago, and his subsequent observations have led him to the conclusion that they are an occasional important source of unsuspected sewer air pollution of the interior of houses, and the pathological consequences thereof. He has found them especially co-existent with enteric fever and diphtheria where complete freedom from chances of sewer air poisoning was believed to exist. The corrosions and perforations were most frequently observed in the upper extremity of the pipe, and, if there were a bend or arch in it, on the upper portion of the bend. The corrosions invariably proceeded from within outwards. Dr. Fergus has the following observations on this subject in a pamphlet he has published on "*The Sewage Question: with special reference to traps and pipes.*" (Glasgow, Porteous, Brothers, 1874):—

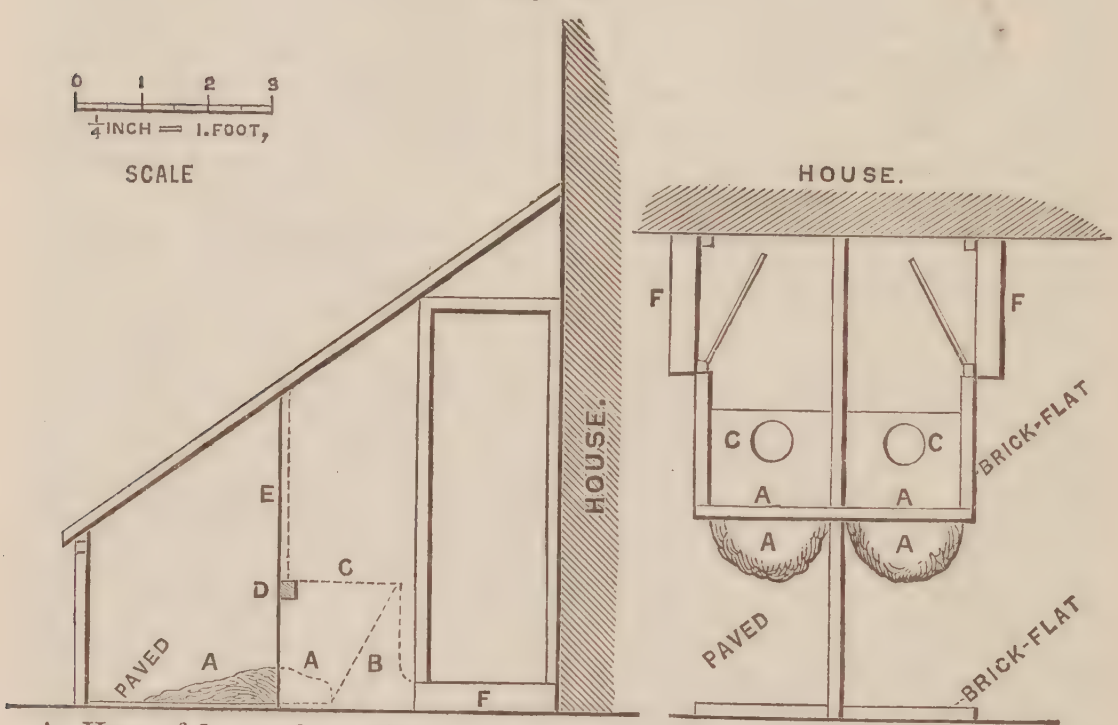
"Lead has generally been used as the material for soil pipes, and as we have seen how capable it is of corrosion, it becomes a very important sanitary question to inquire how long a good lead soil pipe will hold out. I have been studying this question for years, and it is now about seven years since I first exhibited decayed pipes in public, yet, I would not wish to dogmatize on the subject, but rather give approximations, and would remark that the time will vary under the various circumstances according to the strength and rapidity of the flow of the sewage, as well as the original thickness of the pipe. But after allowing for this, we must broadly distinguish between soil pipes which are ventilated and those which are not. By the former I mean when the pipe is carried up to the roof of the house and open to the external air; by the latter, I mean when the pipes are closed up. Of these last-mentioned, the duration may be stated to be about 12 years, the extremes of variation being from a minimum of 8 to a maximum of 20 years. In ventilated pipes the duration may be stated to be nearly double, running from 21 to 33 years, the extremes of variation being from 18 to 30 or even more years. The practical sanitary conclusion which it concerns us all to keep in mind is, that any house, no matter how carefully or well built, may become unhealthy from this source, and that when cases of typhoid fever, diphtheria, &c. occur, the pipes should be thoroughly inspected, especially their upper surface, and the whole of the soil pipe uncovered. I must strongly insist on this, as in many cases the plumbers have declared pipes to be all right, which turned out to be very defective when uncovered. For some years back, I have insisted on a careful

examination of the soil pipes wherever I have cases of typhoid or diphtheria, and in every case where I could get this carefully carried out, I have detected these perforated pipes, or sewer air getting into the houses in some other way," (p. 21).

Butleigh.

Butleigh (*Somerset*).—I had an opportunity of examining at Butleigh an improved privy which Ralph Neville-Grenville, Esq., M.P., is introducing among his cottages. This privy is most instructive as showing by what simple means the abounding nuisance of the common privy, and the indecency connected therewith, which too commonly exists in rural districts may be often got rid of. The change Mr. Neville-Grenville has effected from the old-fashioned privy is shown in the accompanying drawing (Fig. 1.), copied from an article by him on "Cottages" in the *Journal of the Bath and West of England (Agricultural) Society* for 1873.

Fig. 1.



A. Heap of dry earth or ashes in open shed.
B. A stone slab.
C. Seat.
D. Joist on which rests the brick or lath-and-plaster wall, E.
F. Step.

Below the joist D the privy-pit is open, admitting of the soil being covered from behind; or a shovelful of dry earth or ashes may be thrown upon the soil through the opening in the privy seat.

This change consists in filling up the middenstead to the level of the surface of the ground and paving the filled area, extending the roof of the closet so as to cover this, raising the closet floor a step, and with it the closet seat, and placing a flag sloping backwards beneath the seat so as to diminish the space there and place the excrement in a better position for the treatment now to be described. The roofed space in rear of the closet, the area of the former middenstead, is left open on the side of approach, and is used for the deposit of the ashes, and these failing for a deposit of dry earth. The cinders are separated from the fine ash by a common riddle, the former for re-burning, the latter for covering the excrement, and if the fine ash should be insufficient dry earth is applied: or both fine ash and dry earth are used together. I examined several of the improved privies, and in every instance but one found the excrement fully covered and an absence of all offensive odour; a slight odour in the excepted instance arising from imperfect application of the fine ash. The efficiency of Mr. Neville-Grenville's arrangement equals its

simplicity; and it was noticeable how more decent privy arrangements had begotten a greater care for the orderliness of the privy and its vicinity. In one instance, the opening to the space behind the closet was closed by a neatly constructed screen of straw.

Bradford.

Bradford, *Yorkshire* (1871, population, 145,830; inhabited houses, 29,408).—In 1872 I had to report on the state of middenstead nuisance in Bradford among other sanitary defects of that town. The Corporation has recently approved a form of midden-closet, which, while presenting certain improvements upon the old-fashioned midden-closet, has defects so grave that it is desirable to note them here for the sake of warning. The approved midden-closet is directed to be constructed according to the following instructions:—

"The foul earth under the old privies and ashpits to be entirely taken out and at once carted away, and the old ashpits to be filled in with concrete.

"The privies are to be built in the manner and form, and to the dimensions shown in the detail drawing. (*See* Plate IX).

"The ashpit to be sunk four inches below the sill of the emptying door, and the bottom to be flagged and made watertight, and laid with an inclination of not less than nine inches from the door towards the back or shallow end of the ashpit.

"Across each ashpit there must be a grating fixed in such position as shown in the detail drawing.

"Each privy and ashpit to be covered with large Yorkshire flags or landings.

"The upper door of the ashpit to be provided with a thumb latch, as shown in the detail drawing, and the lower door of the ashpit to be provided with a catch-lock, capable of being opened with an ordinary railway carriage key.

"The whole of the works are to be executed in a good and workmanlike manner."

The grating approved at the time of my recent visit to the town was formed of stout iron wire with a 2-inches mesh.

I visited several blocks of privies which had been erected in accordance with this plan, and found in each instance the grid loaded with a foul mass of ashes and house refuse; and such ashes as had passed through lay in a heap beneath the grid and between the deposits of excrement, leaving the latter quite exposed. In one instance of a block of four privies, not only was the grid laden, as described above, and the excrement exposed, but the urine and other wet in the middenstead was running from beneath the door for emptying, forming a sluggish stream to the nearest yard-gulley. The offensiveness of this block of privies was not less, if, indeed, it were not greater than that of an old-fashioned open midden-privy.

In fact, the position of the grid is such that, if the ashes be raked above it, the fine ash will not fall upon the excrement; and the capacity of the middenstead, in accordance with the arrangements for night-soil scavenging, is sufficient to hold several weeks' accumulation of ashes and excrement, while its shallowness makes necessary frequent systematic scavenging if nuisance is to be avoided.

Gloucester.

Gloucester.—At Gloucester I had an opportunity of examining two forms of Dry Closet in experimental operation which had been designed by Dr. Francis T. Bond, the medical officer of health for the Gloucestershire Combination of Sanitary Authorities, to meet certain require-

ments of his district. One of these closets is described by Dr. Bond as the closet with "*external ash distributor*," the other as the closet with "*internal ash distributor*." The following diagrams, to which I attach Dr. Bond's descriptions, illustrate the arrangements of these different forms of closets. Both forms may be fitted with urine separators, but this arrangement is shown only in the diagram of the second form :—

Fig. 2.

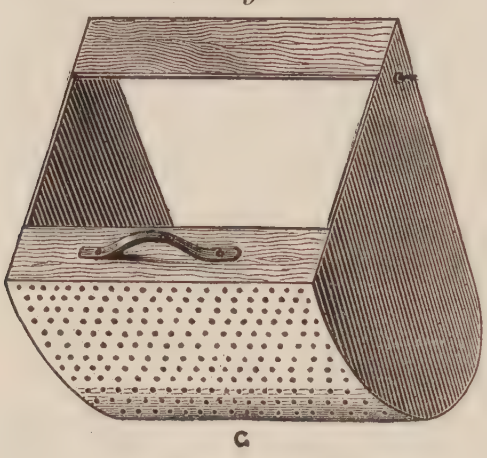
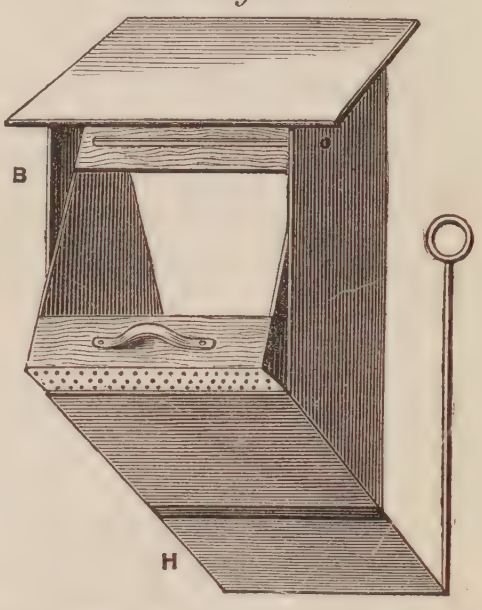


Fig. 3.



Closet with External Distributor. Distributor (*Figs.*2 & 3).—G a cradle with sifting bottom suspended in a box B, which is attached to the side or back wall of the closet on the outside. At the bottom of the box is a sloping board H hinged at one end, on which the ash falls. To the other end of this board is attached a wire, the free end of which rises through the seat of the closet, so that on pulling it up by the handle which is attached to it, a jerking motion is given to the board, which shakes the ashes from it into the receptacle. The cinders are removed from the cradle by merely pulling it forward, when they fall out of it through a shoot which is placed in front of the sifter, into the coal box or other receptacle which may be placed beneath to catch them.

Fig. 4.

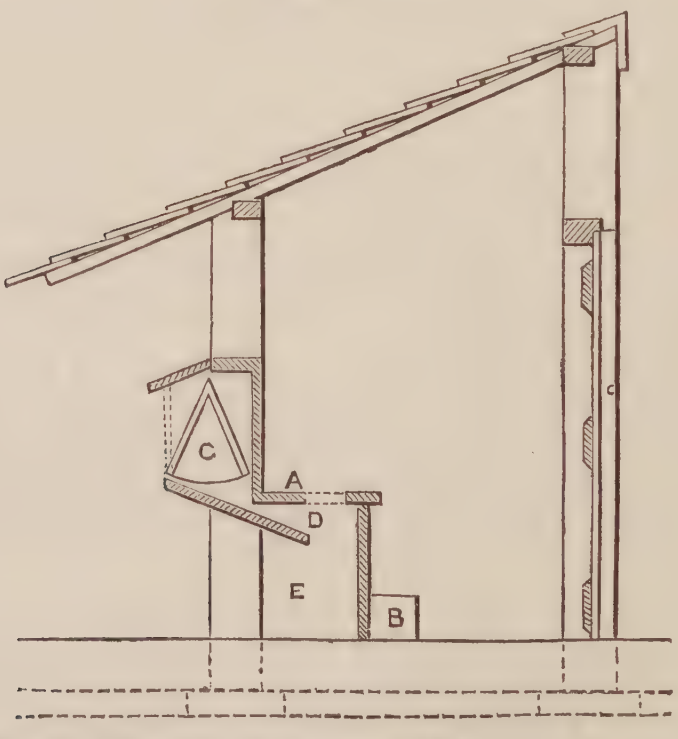


Fig. 4. *Section of Closet with External Distributor attached.*—A, seat B, step ; C, cinder sifter ; D, ashes shoot ; E, space for moveable receptacle.

Fig. 5.

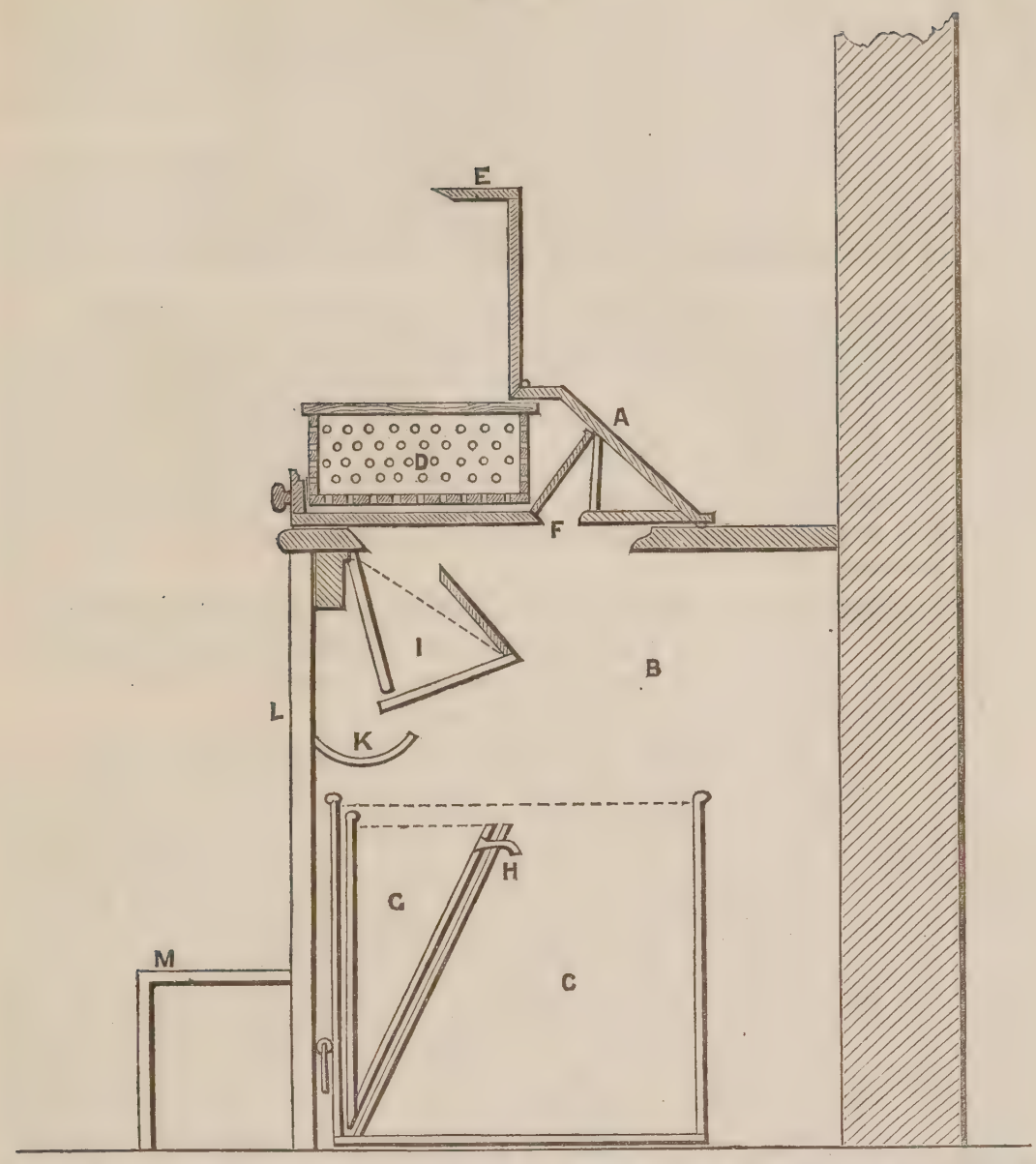


Fig. 5. Closet with Internal Distributor.—"A, ash-distributor with lid, E, open, showing sifter, D, inside and aperture for discharge of ash, F. In B, the space beneath the seat, is seen the receptacle C, which is a bucket specially constructed for the purpose, with a cover (to be used when the bucket is removed for cleansing), a handle at the top, and one near the bottom in front. At G is seen the urine receptacle, a separate vessel, which can be readily lifted out of the bucket by a handle on either side to allow of the contents being poured out. At H is an over-flow vent, so that in case the vessel is allowed to remain until it becomes over-full, the urine will run over into C and thus give indication of the need for attention. At I is the separator (the real shape of which cannot be represented in section), consisting of three elements intended to meet the conditions of adult males and females and children respectively. K is a gutter into which the urine passes, except where a bucket with separating vessel is used when the urine falls out of the separator into the latter. The riser of the seat, L, should in all cases be attached to the seat in such a way that it can be removed for the purpose of taking out the bucket. M is a small support for the feet which may be attached to the riser, and which is required in consequence of the increase in the height of the seat, which is necessary in order to allow of a bucket of fair size being employed.

"*Action of Apparatus.*—A person on entering the closet raises the distributor A, which then rests in the vertical position against the wall. In so doing he gives sufficient motion to the ashes inside to fill the receptacle which measures the charge. On leaving the seat he replaces the box (as he is requested to do by a notice which is fixed to it) and in so doing discharges the charge of ashes through F into C. The sifter is large enough if filled with ashes, to hold sufficient for 10 or 12 uses of the closet. Hence if properly filled it need

Gloucester.

not, in the case of an ordinary household, be refilled more than every other day. Under similar circumstances the urine receptacle need not be emptied more than once a week, and the bucket itself more than once a fortnight. The operation of emptying the urine vessel is not more offensive than emptying an ordinary chamber pot, and the bucket itself, when full, may be carried through a house without the slightest unpleasantness being perceived.

"The dimensions of the seat, to allow of the above arrangements being adopted, should be as follows:—From before backwards not less than 20 inches, divided as follows; from front edge to front margin of hole $2\frac{1}{2}$ inches, from front to back margin of hole $10\frac{1}{2}$ inches, from back margin of hole to wall 7 inches.

"It is not essential that the urine should be collected in the soil bucket. It may be conducted from the separator by a piece of piping into a vessel placed outside the closet for its reception. Where this can be conveniently done it is perhaps the better plan, as any neglect to empty the vessel will be more evident and its results less offensive than when this takes place inside the closet. Or, where a drain is convenient, the urine pipe may be connected with it, and the urine got rid of in this way. Or, again, where no well is immediately near, the urine may be carried into a small covered cesspool made close to the closet."

My observations were limited to the action of the cinder-sifters in the two closets. Both forms appeared to act efficiently, but the greater complexity of the internal form will no doubt restrict its useful application as compared with the simpler external form.

At the time of my visit to Gloucester, Dr. Bond was engaged in addition to perfecting the operation of his dry-closets, in an interesting experiment on the disposal of liquid house-refuse. The experiment was too incomplete to admit of description here, but the principles upon which it was being worked out may be mentioned. Dr. Bond believes that it is quite practicable to depurate liquid house-refuse before it leaves the premises, so that what flows away shall not be productive of nuisance. This he proposes to effect by subjecting the refuse to a combined process of straining, chemical precipitation and filtration. The apparatus for the purpose consisted of an ordinary waterbutt with a simple strainer at the mouth and floating filter within. The most effective form of precipitate Dr. Bond had not fully determined at the time of my visit; but such results as he showed me of his experimental trials augured well for a successful issue. [Dr. Bond has since informed me that he has made several unessential changes in the "closet with internal distributor;" and that he has determined two available forms of precipitate. One of these which is also a deodoriser, and is believed by Dr. Bond to be a true disinfectant, is termed by him *cupralum*, and is a mixture of cupric dichromate, and aluminic sulphate with terebene.]

Tring.

Tring, Herts (1871, population 4,045; inhabited houses 850).—The urban sanitary authority of Tring has adopted at the suggestion of its medical officer of health, Dr. C. E. Saunders, a modified form of privy, of which a diagram is given in Plate IX[a]. The peculiar characteristics of this privy are a shallow pit, and a bin placed at the side of the seat, for containing dry-earth or ashes. The cottagers where this form of privy has been erected are instructed to keep the bin provided with one or other of the materials named, and after each use of the privy, to throw upon the deposited excrement a scoopful of the dry-earth or ashes. I saw several of these privies which had been some little time in use. Where reasonable attention could be secured in covering up the excrement with the earth or ashes, the freedom from nuisance was marked. In view of the necessity for frequent removal of the contents of these closets and of their storage in garden plots, it appeared to me desi-

rable, as a rule, where no proper care from the users can be reckoned upon, to have all ashes and dry household refuse thrown into the pit: to use them, in fact, as middensteads. By this simple plan there would probably be more likelihood of nuisance being avoided among the careless both in the privy and in the subsequent disposal of the contents of the pit.

Tring.

[A somewhat similar privy arrangement to the above, and method of use, has been adopted by the rural sanitary authority of St. Neots. In this form of privy, a box or scuttle to contain earth, ashes, or other deodorising material is directed to be placed upon the floor of the privy.

A completer arrangement has been designed by Dr. Baylis the medical officer of health to the West Kent combination of sanitary authorities. He provides, as in the Tring privy, for a bin attached to the seat to contain dry-earth, but a metal pail forms the excrement receptacle, and in rear of the privy he constructs a proper covered dust-bin. Into this dust-bin the contents of the pail can be deposited, along with the ashes and dry house-refuse, when they cannot be at once used for the garden.

The St. Neot's privy and Dr. Baylis' improved privy and dust-bin I have not seen in use.]

3. *Excrement Disposal by Pail-Closets.*

Rochdale.

Rochdale (1871, population, 64,754; inhabited houses, 13,933). — Six years ago the Rochdale Corporation undertook a twofold experiment in excrement disposal, designed to abate the nuisance from middensteads, and to put their contents to more profitable use. The experiment consisted in the conversion of a certain number of privies into pail-closets, some being managed on the Goux system, others in a simpler manner. The conversion, where accomplished, at once did away with the nuisance from middens by the destruction of the middenstead, and both methods of managing the pail-closets proved equally effective in keeping under control and in diminishing to an extremely insignificant amount, as compared with the common midden, nuisance from excrement. After several months trial the Goux system was set aside, the simpler method of managing the pail-closets adopted, and out of this simpler method has been developed that plan of dealing with the excrement and dry refuse of households known as the "Rochdale system."

A report of the sanitary committee of the Corporation, under whose supervision the pail-closet experiment had been carried out, and which was published in August 1869, stated, as reported in that year by Dr. Buchanan and myself, that in both systems of management applied to the pail-closet, "the essential condition of the trial, *frequency of removal*, had been secured; that the system of removal had been "thoroughly approved by all who had had experience of it; and that it "had not failed under most varied conditions, having proved equally "efficacious in the highly-rented house with its own closet, in the "lodging-house where great numbers were accommodated, and in the "factory and workshop. In the subsequent manufacture of the dejections and ashes into a saleable manure, the committee concluded that "the Goux system was less advantageous than the use of tubs without "absorbent linings."

When Dr. Buchanan and I visited Rochdale in 1869, 500 middenstead privies had been converted into pail-closets, the other arrangements for the excrement disposal of 45,000 people, occupying 9,000

houses, consisting of 4,000 middenstead privies and 300 waterclosets. In 1872 the Borough was much enlarged, and within this extended area, at the time of my visit (September 1874), the number of pail-closets amounted to 4,397, of which upwards of 3,200 were within the limits of the Old Borough (3,250, January 1874); the estimated number of middenstead privies to 2,000; the waterclosets remaining about the same in number as in 1869.

The Rochdale system of excrement disposal consists in the systematic removal at weekly, or shorter intervals, of the excrement and dry refuse of households, the collection of the excrement and dry refuse in pails, each separate from the other, the manufacture of the excrement with fine coal ash in a particular manner into manure, and the profitable utilisation of the rest of the dry refuse.

In putting this system into force, the following rules were acted upon by the Corporation, as stated in a report published in December 1873:—

"1. That the privies to all new houses should be on the new system.

"2. That all additional privies to old property should be on the new system, and be accompanied by the alteration from the old system to the new of all existing privies to the same property.

"3. That all old privies being rebuilt should be on the new system.

"4. That the first cost of the ash tub and receptacle for the excreta should be paid by the owner."

No difficulty was found, it is stated in the report referred to, in carrying out these rules, nor has "complaint or opposition been made, "and in no case has the Corporation had to exercise any legal authority "to enforce them. This feature is, no doubt, owing to the facts that the "old form of privy and ashpit is more expensive to build than the new "one; that the privies under the new system are much more cleanly; "that from the absence of moisture they are more durable; and that "they need less repairs than those under the old system."

The progress made in the establishment of the new system from year to year is shown by the following figures:—

Rochdale System.

Year ending	No. of Privies.	
	Old Borough.	Extended Borough.
1870, March 31 -	527	—
1871, „ -	1,070	—
1872, „ -	1,690	—
1873, „ -	2,309	—
1874, January -	about 3,250	—
„ September -	—	4,397

The form of privy (closet) is not prescribed by a formal specification, but a pattern (*Plate* X.) for builders, which may be modified to suit special requirements of space, is placed in the yard of the manure works; and certain structural details are required of which I subjoin a summary.* An approved form of adaptation to new buildings is drawn

* The following is a summary of certain structural details required in pail-closets:—

Floor of privies and ashpits to be flagged with 3-inch flags; lintels to be $4\frac{1}{2} \times 3$

in *Plates* XI., XII. In the pattern it is shown that the excrement pail may be removed either at the back or side of the seat, or at the front; the seat being hinged and its front made moveable as a slide or on hinges to admit of this. The seat itself has a deep metal rim beneath the aperture for directing the urine into the pail. The building must be effectively roofed, and the floor is required to be flagged with Rochdale flags at or above the level of the court or passage; and in the case of reconstruction of middenstead privies, the middenstead must be properly filled to the same level. In certain instances of the pail-closets which came under observation, the space for the ash-tub was needlessly large, and had given occasion to some unsightly littering of dry refuse upon the floor.

Two kinds of *excrement pail* are in use, one for houses, the other for factories. The former is a wooden pail formed from the half of a disused paraffin cask, with handles attached and with lids (*Plate* XIII.). The latter is a galvanized iron pail, also with handles and lids. The wooden pail has a capacity of 100 lbs., and costs complete for use 4*s.* 9*d.* The metal pail, of larger capacity, costs 9*s.* 6*d.* The wooden pail is of the same kind as was in use in 1869, and it is still held to be more convenient and economical than a metal pail for the purpose to which it is put. The metal pail deteriorates somewhat rapidly at the bottom, and a wooden bottom is now being substituted for the metal when it needs repair. In 1869 the lid of the pail was single, and it was fixed in place so as to prevent stink being diffused from the contents during removal by an india-rubber packing. A different arrangement is now adopted, two lids being used, an inner and an outer, both resting within a groove inside the pail, the outer lid fixing the inner lid, as shown in *Plate* XIV. These lids being made of metal, I observed in a few instances that they had been battered by use out of form, and consequently did not fit into the groove of the pail as closely as was desirable.

The *ash tub* is usually a tub with handles in the form and dimensions given in *Plate* XIII. I noticed in the course of inspection that it would be well that the scavengers should be provided with the means of scraping, and have instructions to scrape such tubs as from whatever cause might be furred within.

The *removal* of the excrement pail is effected in a covered van, and of the contents of the ash tub in an open cart. Both van and dust cart differ in design from the van and dust cart used in 1869. The van (*Plates* XV., XVI.) is constructed to hold 24 excrement pails arranged in two rows, and placed within it from either side, flaps being raised for the introduction of the pail. The flaps when fastened down rest upon hollow india-rubber beading, which effectually closes the interstices between the lid and the body of the cart. The *dust cart*, which in 1869 was a covered vehicle, is now a simple open cart (*Plate* XVII.).

The arrangements for the removal of, and process of removing the excrement pails and dry house refuse are as follows:—The town is divided into six districts for the purposes of removal, and the dry house refuse is removed at the same time as the excrement, a dust cart accompanying each night-soil van for the purpose. The removal is all

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spars 3 × 1½ and 16 inches, centre to centre; wall plates to be 4½ × 3; roof covered with Welsh slates 20 × 10, lap, 3 inches; ceiling of privies, lath and plaster to spars urine flags to be 1½ inches thick; seats 1¼, nosed and fixed on bearers; door frames, 4½ × 3, wrot., rebated, and chamfered; doors, 1 inch, and edges 7 × 1¼, T hinges and secured with latch and catch; each door to have lock and keys; wood gutter 6 × 4, with 2 inches down-spout, head, &c.; iron conductors to be fixed under privy-seat.

effected during the ordinary working hours of the day, the vans commencing their rounds at 7.0 a.m., and ending at 5.30 p.m. Each night-soil van makes five rounds daily. It leaves the yard laden with clean empty pails, each pail containing a quantity of a "disinfectant," and returns carrying the pails containing excrement, for which the empty pails have been substituted. The process of substitution is effected by the scavengers withdrawing from beneath the closet seat the pail containing excrement, covering this up with the lids already described, removing it to the van, an empty pail being left in its place, and on placing the pail in the van sprinkling over the outer lid a little carbolate of lime. The ash tub is then carried to the dust cart and its contents simply tilted into it. Each pail closet is numbered and registered, and the scavengers proceed from closet to closet systematically, according to the portion of their district within the day's beat, reporting at the end of each round the closets from which the pails had been removed, and those, if any, which had been omitted. The greatest number of omissions for any one month in the whole town has been 42, for any one week 14. Each Monday the scavengers' returns are balanced, and a supplementary van with dust cart sent out to rectify omissions. In the case of lodging houses and closets used by several families the excrement pails are removed twice or thrice weekly.

On the return of the vans and dust carts to the yard, the collections of excrement and dry house refuse are immediately dealt with. The contents of the ash tubs are screened by machinery, to separate the fine coal-ash from the cinders and other refuse. The cinders are then set aside for use in the furnaces and for sale, the refuse metal, leather, and rags are sold, and the vegetable refuse burnt. The fine coal-ash is used in the process of manure manufacture. Deposited on the floor of sheds trenches are made in it, and into these trenches the contents of the excrement pails are poured as received. The excrement is then covered with fine ash, and a quantity of sulphuric acid is added to facilitate drying. At intervals of about seven days other excrement is added to the mass, and this process is repeated three times. The mixed mass of excrement and coal-ash is then left undisturbed for a period of 14 days, when it is turned over. After another seven days it is again turned over. Then it is left undisturbed a week, when the process of manufacture is complete, and the mass has become pulverulent and inodorous. The proportion of excrement to fine ash in the finished manure is 80 parts of the former to 35 parts of the latter. The sulphuric acid added is in the proportion of 25 lbs. to 1 ton of the excrement.

After the excrement pails have been emptied, they are arranged upon a stand and effectually cleansed by water delivered under 40 lbs. pressure from a hose; and before being again sent out of the yard there is placed in each tub a quantity of "disinfectant" (a half-pint in the cooler months and one pint in the warmer) made at the works from the following formula:—

Chloride of lime - - -	- 10 parts.
Crude alum - - -	- 10 „
Brown sugar - - -	- 1 „
Water - - -	- 100, mix.

This antiseptic has been adopted as giving the most satisfactory effects in arresting decomposition, after a trial of sulphate of iron, and other antiseptics. The vans also are sluiced out after each round; once a week they are thoroughly cleansed inside and out; and occasionally the interior is coated with gas-tar.

Of the economical advantages of the Rochdale system actually and as

compared with the midden system, the following tabulated statements, prepared for the Corporation, have been submitted to me. These statements show that while for the period referred to in the first table, the net cost per annum, per 1,000 of population, for the removal and disposal of excrement and dry house refuse on the midden system in the towns named was in one instance (the maximum) 77*l.*, and in another instance (the minimum) 35*l.*, the average for the whole of the towns being 57*l.*, the net cost of the Rochdale system in 1873 was 19*l.* only. I subjoin a detailed account of one week's collection and manufacture on the new system, taken from the explanation already referred to.

Midden System.

Table showing the net Cost of removing and disposing of Night Soil, &c., on the Midden System, in the surrounding Towns whose populations are similar, and whose market for the sale of manure is the same as Rochdale.

—	Cost 1872.	Population.	Cost per 1,000 persons per annum.
	£		£
Rochdale - - - -	1,596	22,484	71
Oldham - - - -	6,478	84,000	77
Bolton - - . -	2,966	84,853	35
Manchester - - -	21,700	360,000	60
Salford (township) - -	4,508	83,280	54
Pendleton (township)- -	1,164	26,574	44
Ashton - - - -	1,982	32,800	60

Rochdale System.

Table showing the Cost of the Removal of the Night Soil of the Town of Rochdale, and its Manufacture into a Manure by the Rochdale System.

Year ending	No. of closets.	Collected. Excreta.	Collected. Ashes.	Manure. Made.	Manure. Sold.	Houses.	Mills and Workshops.	No. of Persons using the Privies.	Gross Expenditure.	Manure made.	Net Cost
	Tons.	Tons.	Tons.	Tons.	Tons.				£ s. d.	£ s. d.	£ s.
1870, Mar. 31	527	398	611	377	217	1,048	12	5,797	694 17 6	537 19 5	156 18
1871 „	1,070	846	1,521	1,059	699	2,944	31	11,770	1,538 7 11	1,380 14 3	157 13
1872 „	1,690	1,431	2,405	1,556	1,019	3,174	39	19,283	2,392 13 0	2,167 17 3	224 15
1873 „	2,509	1,989	3,413	1,989	412	4,560	69	26,934	3,463 6 11	2,826 16 1	637 10
1874 „	3,980*	3,516	5,196	3,497	1,545	7,287	106	†43,500	5,284 3 7	4,449 11 2	834 12

* Increase 1,471, of which 165 were for new houses.
† Being two-thirds of the borough.

Statements showing separately the Cost of Collection and Manufacture on the Rochdale System.

Week ending September 24th, 1873.

Number of privies on the new system - - -	- 3,354
Number of dwelling-houses to do. - - -	- 6,213
Number of factories and workshops to do. - -	- 76
Number of population - - - - -	- 36,894

The total weight collected from the before-named places was—

Ashes, - - - - - - -	- 96 tons.
Excreta - - - - - - -	- 71 „
Or a total of - - - -	- 167 tons.

App. No. 7.

On Excrement Nuisances, by Mr. J. Netten Radcliffe.

Rochdale.

No. 1. COST OF A WEEKS' COLLECTION.

	£	s.	d.
3 receptacle washers, at 22/0 per week	3	6	0
2 labourers to load and unload carts	2	4	0
16 collectors, including 8 carters, at 22/6 per week	18	0	0
Keep of 8 horses, including farriery and saddlery, but not rent	6	16	0
Horse keeper	1	5	0
3 labourers or wharfmen for storing and loading for sale, each labourer having to store 9 tons odd each per day in addition to loading	3	6	0
Book keeper and wharfinger	1	10	0
Office boy	0	15	0
Town inspector and manager	2	0	0
Carried forward	39	2	0

	£	s.	d.	£	s.	d.
Brought forward				39	2	0
The capital and depreciation is as follows:—						
Receptacles value 1,200*l.*, depn. per annum	240	0	0			
Ash tubs value 125*l.*, depn. per annum	25	0	0			
Horses and gear value 700*l.*, depn. per annum	100	0	0			
Vans and carts value 450*l.*, depn. per annum	64	0	0			
Capital in plant 2,475*l.*, interest	123	15	0			
Rent of wharf and stables, rates, taxes, &c.	150	0	0			
	£702	15	0			
702*l.* 15*s.* per annum is per week				13	10	3
Total weekly cost of collection equal to 6/3½ per ton				£52	12	3

No. 2. MANUFACTURE: A WEEKLY BALANCE SHEET.

Dr.	£	s.	d.	£	s.	d.
Wages:—						
3 cinder sifters @ 22*s.* 6*d.*	3	7	6			
1 manager and engine tender	1	10	0			
2 labourers	2	4	0			
1 boy	0	7	6			
				7	9	0
Materials:—						
Chemicals	8	0	0			
Bags	1	0	0			
Implements and machinery	1	0	0			
				10	0	0
Depreciation:—						
2 per cent. per annum on 4,730*l.* for plant	1	17	0			
				1	17	0
Capital:						
5 per cent. per annum on 4,730*l.*				4	10	0
				£23	16	0

Cr.	£	s.	d.	£	s.	d.
By 71 tons of manure @ 1*l.* per ton				71	0	0
By 28 tons of cinders for sale @ 1*s.* 6*d.* per ton				2	2	0
By rags, iron, glass, &c.,— say				0	5	0
				73	7	0
Deduct—						
By cost of manufacture, as on Dr. side	23	16	0			
By commission to agents on sale of manure	7	2	0			
				30	18	0
By net profit on manufacture				£42	9	0

	£	s.	d.
The cost of collection this week was	52	12	3
Deduct profit on manufacture	42	9	0
Making the total cost to the town for the removal of excreta and house refuse of a population of 36,894, being at the rate of 14*l.* 6*s.* 8*d.* per 1,000, per annum.	£10	3	3

The manure made is here put down at its selling price, although its value as now made is much greater than it was formerly, as four tons of night soil are now used to $1\frac{3}{4}$ tons of ash.

The 167 tons of night soil and refuse thus dealt with by the manufactory was disposed of as follows :—

56	tons	of cinders.
8	„	refuse, rags, glass, paper, &c.
32	„	water evaporated.
71	„	manure made.
Total 167		

Another statement by way of comparison between the economic working of the midden and pail systems has also been made to me. Taking the whole borough within its enlarged limits, 44,000 of the population are under the pail system and 22,000 under the midden system. The staff and plant required for the scavenging of 4,000 closets under the pail system consist of 11 carters, 11 other men, "guards," 9 night-soil vans, 10 dust carts, and 11 horses. The staff and plant required for the scavenging of 2,000 closets under the midden system, consist of nine carters, nine emptiers, one foreman, 10 carts, and 9 horses.

When Dr. Buchanan and I studied the working of the Rochdale system, as it was seen in operation in 1869, we formed a high opinion of its advantages as a means of controlling and abating excrement nuisance, particularly as compared with the system for which it was being substituted. In the recent inspection I have again submitted the working of the system, so far as it relates to the question of nuisance, to a detailed examination, particularly in view of certain objections which have been urged against it. These objections referred to asserted offensiveness in the changing of the excrement pails and their being carted through the streets, and to averred danger arising from the collection of unmixed excrement in pails. The construction of the closets, as I have already had to observe, at once removes the evils of the middenstead. The absence of marked excremental odour of separate closets used by single families, in the greater number of the instances examined, after seven days use, was remarkable. In one instance only, that of a block of closets opening beneath a common roof and into a common passage, was the odour striking; but even in this case the odour was only perceptible within the building, and was quite inconsiderable compared with the stink of a neighbouring middenstead. The removal of the excrement pails from beneath the closet seat, the affixing of the lids and carriage to and placing within the night-soil van, were done with great celerity and without a trace of nuisance; and I satisfied myself that in this process, and in the subsequent cartage of the tubs, nuisance could only arise from gross carelessness of the scavengers. The Corporation, in addition to exercising a strict supervision over the process, are desirous to diminish even the semblance of nuisance from the removal of the pails. An experiment is now being tried in one district of the town, containing 993 pail-closets, of collecting the excrement pails apart from the collection of the contents of the ash tubs. By increasing the number of vans in this district, and employing the whole of the men, in the first place, upon the removal of the excrement pails, it is hoped to complete this part of the work before 11 a.m., and perhaps even earlier; the collection of the dry house refuse being left to the after part of the

Rochdale.

day. Should this experiment succeed, the same arrangement will be adopted generally throughout the town. I made particular inquiries of householders as to offensiveness arising from the pail system; but in every instance decisive testimony was given as to its inoffensiveness as compared with the midden system, and an equally decisive opinion expressed against a return to the latter system, whether as regards mode of depositing the excrement or of its removal. In order to leave nothing to the imagination, I sought to obtain permission, after inspecting the work of removing the pails and their cartage in the night-soil vans, to have the contents of a middenstead removed before nightfall. But I was foiled in carrying out this perhaps most needless experiment in stink by the officials of the night-soil department objecting to undertake the task during the daytime, for the very significant reason that it would provoke disturbance in the town. Complaints to the Corporation of offence from pail-closets rarely arise; complaints as to offence from midden closets are the rule, for a midden closet is not cleansed except on request of its owner or of the inspector of nuisances—until, in short, it has become a nuisance in the ordinary sense of the word.

The objection urged against the pail-closet as dangerous to health rested upon the assumption that the collection of the unmixed excrement and its cartage through the town would disseminate enteric fever, and other diseases connected with excremental nuisance. No facts are stated in support of the assumption, and it is sufficient to say that the opportunities of such dissemination from the pail-closet as managed at Rochdale are wholly insignificant as compared with the midden-closet for which it is being substituted. It has been overlooked, moreover, by the objectors that the pail-closet gives particular advantages for effectively limiting the prevalence of the diseases referred to. This is one of the reasons which have influenced the Corporation in adopting it.

It is no part of my business to express an opinion upon the ultimate disposal of the excrement and dry house refuse, but I may observe that every care is taken to avoid nuisance in the manufacture of the manure.

Manchester.

Manchester (1871; population, 351,189; inhabited houses, 67,204).—When Dr. Buchanan and I visited Manchester in 1869 there were 10,000 waterclosets and 38,000 middensteads in the city; a middenstead being in many instances used in common by several families. Waterclosets were discouraged except in higher class houses; and changes now being made by the Corporation in the construction and regulation of privies other than waterclosets will tend still further to their discouragement. In 1869 the Corporation fully recognising the evils arising from the common privy with open middenstead, had instituted itself and permitted others to institute several experimental methods for obviating the offensiveness and unwholesomeness of this form of excrement disposal. These methods were designed to secure in various ways dryness of the contents of the middenstead; diminution of their offensiveness by covering the deposited excrement with ashes and house refuse, and by restricting the amount of accumulation; dispersion of any noxious gases formed during decomposition of the contents at some safe point; and prevention of leakage or soakage from the middenstead. Roofing and drainage of the middenstead, and occasionally a mechanical device for diverting into the drains urine passed at stool, constituted the principal arrangements for obtaining

dryness. Sifting ashes through a screen so arranged that the fine ash fell upon an inclined plane and was directed beneath the privy seat, or casting the ashes and house refuse in bulk beneath the privy seat, hinged so as to be raised for the purpose, or through an aperture at the level of the privy floor were the means adopted for covering the freshly-deposited excrement, the ashes contributing also by reason of their absorbency to dryness of the middenstead contents. The removal and dispersion of noxious gases formed in the roofed middenstead were sought by a ventilating shaft. Finally the middenstead was restricted in size, and leakage and soakage were provided against by certain peculiarities of construction, or by the substitution of a wood or metal receptacle for the fixed middenstead.

The Corporation at this time required that the several objects aimed at by the arrangements mentioned above should be provided for in all new middenstead privies or middenstead privies which had to be reconstructed, specifying the main structural requirements. These included, with regard to the middenstead, roofing with slates or flags well pointed, and flooring with Rochdale flags of not less than 3 inches in thickness, bedded in mortar, and laid with proper inclination to a drain outlet; and, with regard to the privy, a construction such as to ensure the ashes being deposited upon the excrement, the seat to this end being hinged and having a hinged "riser." The depth of the middenstead was limited to 5 feet from the sill of the emptying hole (2 feet below the level of the ground); and the door of the emptying hole was to be provided with a lock and key of approved pattern.

Notwithstanding the improvement gained in the construction of the common middenstead privy by these regulations, the new middensteads, as Dr. Buchanan and I observed in our departmental report on the subject, were large enough to hold three or four months' accumulation of excrement and refuse; the scavenging arrangements of the Corporation only contemplated the removal of this accumulation when the pit was ready to overflow; and the drainage was fatal to any possible defence of the midden system at all.

Further experience has convinced the Corporation that the accumulation of filth contemplated by the arrangements approved in 1869, although much less than previous accumulation, was inconsistent with wholesomeness of the atmosphere about dwellings; and that the infrequent scavenging which these arrangements involved was not sufficient to meet the sanitary necessities of the city. An examination, moreover, of the drains and smaller sewers in various parts of the city, made under the direction of the medical officer of health, Mr. John Leigh, disclosed a state of things, from the accumulation in them of solid refuse from middensteads, which is best described in Mr. Leigh's own words. He writes in a report, prepared in February 1874, (p. 21) as follows:—

"Some time ago I caused to be sunk in every township of the city a series of shafts down to the drains and sewers situated respectively in courts, passages, narrow secondary streets, and in the broader primary ones. The greatest accumulations I found in the drains at the backs of houses, in courts, passages, and in narrow streets. Some of the drains in these were quite full of solid matter, others had a few inches of space above the deposit. The sewers in the large streets were as a rule comparatively free, though occasionally a large amount of deposit was found. In all openings made into the drains the extent of deposit was generally the greatest at the highest point, gradually tapering off towards the outfall. Upon examination the deposit was found to consist of

small coal, ashes, bits of broken pot and fœcal matter, cemented by the latter into a strong mortar, which after being allowed to stand for a short time gave off very offensive gases, which bubbled up through the deposit. The matter had in fact all been derived from the ashpits and privies. The two figures

Fig. 6.

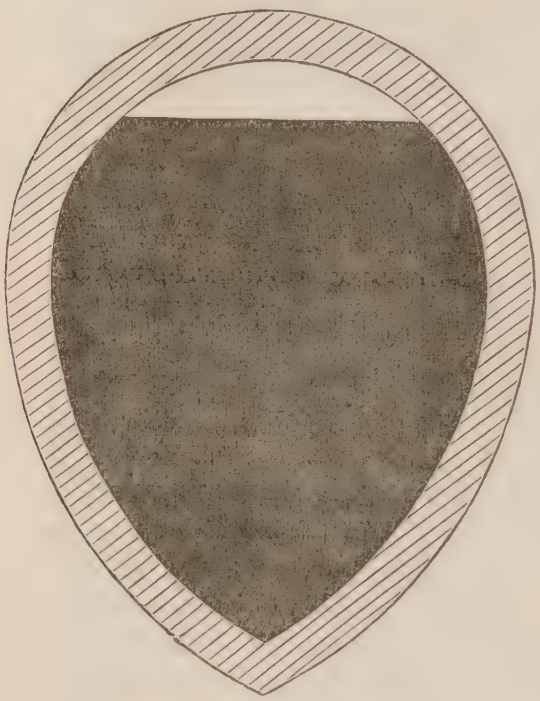
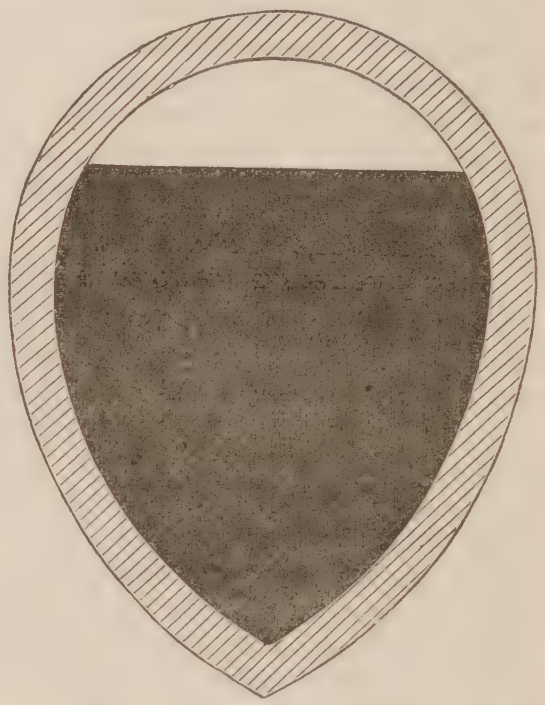
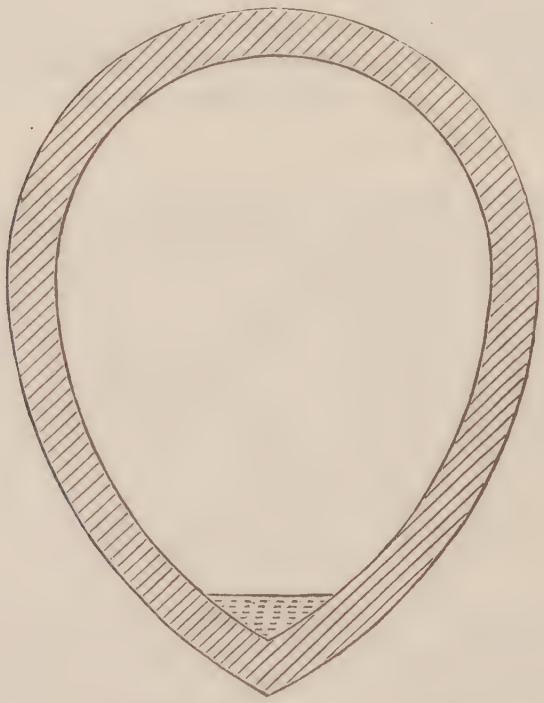


Fig. 7.



(Figs. 6 and 7) represent the sections of a drain in Joddrell Street. It will be seen that the drain is nearly full. The contents were as black as the ink in the diagram, and were excessively offensive. The lowest figure (Fig. 8)

Fig. 8.



represents the section of a drain in a passage behind Collyhurst Road, which had been laid down about eighteen months, and which was not in connexion with any ashpit or privy drain, but drained the adjoining houses. The deposit was about three-fourths of an inch of gray silt or sand. Several drains similarly situated in Chorlton-upon-Medlock were likewise opened with a like result."

In view of the evils left untouched by previous experiments, the Corporation next proceeded to establish a frequent systematic removal

of excremental and other household refuse and to do away with middensteads, substituting for them moveable receptacles. In this way was gradually developed the system of excrement disposal now fully accepted by the Corporation and being put into operation in the city. This system, which involves the reconstruction of all middenstead privies, has already been applied to 6,000 of the 67,000 houses of the city, and is being extended to the rest at the rate of 5,000 houses annually.

The system consists in: 1, the systematic weekly removal (with certain exceptions presently to be named) of the excremental and other household refuse of every house; 2, the substitution of pails for the reception of the excrement and dry refuse, the excrement being deposited in one pail, the dry refuse in another; 3, the covering up of the deposited excrement with fine coal ash; 4, the ventilation in a particular manner of the space beneath and behind the privy seat, in which the excrement and refuse pails are placed; and 5, the utilization of the excrement and other refuse.

The removal of the excrement and other household refuse is carried out by the Corporation itself through the agency of its own staff of men, carts, and horses. As a rule the removal is effected weekly, but in a few cases of small well-ordered families, in which the amount of excrement deposited is insignificant, and its covering up with fine coal-ash can be ensured, a fortnightly removal is authorised; while in lodging-houses and sub-let houses the removal takes place twice or thrice a week according to circumstances. A daily removal will be directed in some localities, if eventually this should be found advisable. The excrement pail, with its contents, is at each removal taken away entirely, a clean pail being deposited beneath the privy seat in its place. The pail, a lid having first been placed upon it to cover the contents, is carried to a covered van constructed after the Rochdale fashion (see *Rochdale* and *Plates* XV. and XVI.), and carted to a depôt. There the contents are emptied out, to be dealt with as described hereafter, and the pail cleansed for re-use. This cleansing was effected by simple brushing at the time of my inspection, the arrangements to be made for washing and disinfecting the pails not having been completed. The contents of the dry-refuse pail are simply emptied into an ordinary scavenger's cart, and the pail replaced. The whole of the process of removal is carried on during the customary working hours of the day.

The use of pails for the reception of the excrement and dry household refuse admits of the old middensteads being filled up, of the drains which formerly ran from these and which were so productive of nuisance being removed, and of the structural arrangements of the privy being wholly kept above the surface of the ground. The excrement pail, made of galvanised iron, is of a capacity of 10 gallons; the dry-refuse pail, made of wood, is commonly 1 foot 10 inches square, and 18 inches high.

The arrangement for covering the deposited excrement with fine coal ash, consists of a cinder-sifter attached to the privy and so designed that the fine ash is directed by a shoot upon the excrement, the cinders falling into a receptacle whence they may be taken for re-burning. The sifter is formed of zinc, with circular perforations half an inch in diameter; this construction having been found by experience less liable to deterioration and to blocking up of the perforations.

Ventilation of the space beneath and behind the privy seat is provided for by a flue which is required to be carried 3 feet above the eaves of the house.

The excrement and dry house refuse are dealt with at the depôt to which they are conveyed in the following manner. The excrement is manufactured into a manure by mixing with it fine coal ash in about equal bulk, and a small proportion of gypsum (1 lb. to 100 lbs. of the

App. No. 7.

On Excrement Nuisances, by Mr. J. Netten Radcliffe.

Manchester.

mingled mass) with the object of fixing ammonia. Subsequently street sweepings and the refuse of slaughter-houses are added. In order to enrich this manure, cottagers are being encouraged to preserve urine, which would otherwise be cast down the drains; the scavengers removing it at the same time as the excrement. The dry house refuse consists chiefly of cinders, broken pots, rags, waste iron, and tin, old boots and shoes, bones, bits of leather, animal and vegetable refuse. The cinders when the arrangements of the Corporation are complete will all ultimately be consumed in the depôt furnaces; the broken pots are ground up with lime and sand for mortar; a ready sale is found for tin and scrap-iron with the copperas manufactures, also for old boots and shoes, bits of leather, woollen rags, and certain animal matters with the prussiate of potash manufacturers, in each case at the rate of 10*s.* per ton. Such refuse as remains unutilized is destroyed by fire.

I add drawings of an elevation and section of the Manchester dry-ash closet (*Plates* XVIII., XIX.); also the detailed specification of the several works required by the Corporation in the reconstruction of privies, together with the illustrative drawings. (*Plates* XX.—XXIV.)

"Specification *of the several works required in the reconstruction of* Privies.

Foul earth. "The foul earth under the old ashpits and privies must be entirely taken out, and at once carted away from the works.

Filling in. "The old ashpits must be filled in where required, with suitable dry hard material, small and well rammed in level courses not exceeding 6 inches in thickness.

Ash-pit floors. "The floor of the ashpit is to be flagged with a Rochdale flag, not less than 3 inches in thickness, properly squared and jointed, bedded in mortar, and laid with an inclination of 1 inch towards the door.

Privy floors. "The floor of the privy is to be flagged or tiled, and laid with an inclination of half an inch towards the doors, and raised 9 inches from the level of the yards, or 18 inches from the level of the passage.

Lintels. "The lintels carrying the $4\frac{1}{2}$ inch division walls, between the flues and the privies, must be set flush with the under side of the privy seat.

Cinder sifter from the yard. "A side cinder sifter must be fixed to each privy, and in all cases where practicable must be fixed so that the ashes can be thrown in from the outside of the privy in the yard, and pass down the shoot directly under the privy seat, as per detail drawing No. 2; but in any case where the receptacle is to be emptied from the front, from under a folding riser and seat, or in other special cases approved of by the health committee, then the cinder sifter must be fixed at the back of each privy seat, as per detail drawings Nos. 3 and 4.

Cinder sifter inside the privy.

Refuse frame. "Wherever side cinder sifters are fixed a refuse shoot must be provided, or a door 12 in. by 9 in. (as shown in detail drawing No. 2), and hung to frame. $4\frac{1}{2}$ in. by $1\frac{1}{2}$ in. built in, for passing refuse, broken pots, &c.

Privy seat. "The privy seats to be fixed on bearers, $2\frac{1}{2}$ in. by 2 in., let into the flag riser at the front, and secured to the lintel at the back, the depth of the flag from the privy floor to the underside of the seat to be 17 in.

Folding seat. "Where there is no yard space, and a privy is shown underneath a room, a folding riser and seat must be provided (as shown on the detail drawing No. 4), firmly braced together by wrought-iron stays, and hinged with strong wrought-iron bands and gudgeons, the gudgeons being either plated and fixed with screws or driven into the lintels which carry the $4\frac{1}{2}$ in. division wall.

Seat cover. "Each seat is to have a fall cover 1 in. thick, hung with 10 in. bands and gudgeons.

Privy doors and frames. "The doors to the privies must be 1 in. thick ledged doors, hung to frames $4\frac{1}{2}$ in. by 3 in., with strong wrought-iron bands and gudgeons, and left 3 in. short at the top.

Ash-pit frame and doors. "The emptying holes of the ashpits shall be 3 ft. 6 in. high by 2 ft. wide inside the door frames, or in special cases (approved by the Health Committee) 19 in. square, and built in with the brickwork, the doors to be cross boarded and finished $1\frac{3}{4}$ in. thick, and hung to frames $4\frac{1}{2}$ in. by 3 in., with strong bands and gudgeons, and secured with a latch approved by the health committee; the door to overhang and to overlap half its thickness, $\frac{3}{4}$ in. on three sides on the inside edge of the frame, and to be left $\frac{1}{2}$ in. short at the bottom.

The bottom of the ashpit is to be 3 inches above the level of the adjoining passage, and sleepers 4½ in. by 3 in., for guiding the receptacles, must be fixed as shown on the detail drawings.

" A galvanised iron receptacle, 15 in. high and 18 in. diameter, together with a wooden receptacle for the cinders, broken pots, &c., 1 ft. 10 in. square by 18 in. high, or in special cases 2 ft. 6 in. long by 18 in. wide and 18 in. high may be procured free of cost, from the Health Committee, at the Town's Yard, 279, Oldham Road, on production of an order for the same. Receptacles.

" A urine guide must be fixed underneath each seat with screws. Urine guide.

" The ashpits must have ventilating flues constructed of brickwork or of earthenware pipes; the size of the flue to be (if square) 9 in. by 9 in., if of circular earthenware pipes 6 in. diameter, and carried when practicable up the side of the wall to 3 ft. above the eaves of the house, and secured to the walls with strong bands and clips. Ventilating flues.

" The privies and ashpits must be covered with either slated or flagged roofs, well pointed with lime and hair mortar. Roofing.

" The privies must have two coats of limewash. Whitewashing.

" All the woodwork with the exception of the privy seats, must have two coats of good bodied oil paint. Painting.

" The yards must each have a trap and grid, placed in such a position that the waste pipe from the slop stone shall discharge itself on to the grid. Yard grids.

" All flagging and other necessary work to be done to the satisfaction of the Committee. Flagging.

" Cinder sifters, urine guides, &c. may be purchased from the Health Committee, at the Town's Yard, corner of Osborne Street, 279, Oldham Road, Manchester. Cinder sifters, &c.

" Patterns of locks and keys, bands and gudgeons, grids and traps, cinder-sifters, and refuse shoots may be seen at this Office, and no other patterns will be allowed. Locks, hinges, &c.

" The whole of the works to be executed to the entire satisfaction of the Officer of Health, and to be certified in writing by him. Work to be satisfactory.

" Written notice must be given at this Office three days before the work is commenced, and also when completed. Notices to be given.

" Inquiries to be made at the Health Office, York Chambers, King Street."

The drawings show the most ordinary arrangement of the new closet, but in inspecting reconstructed privies I was struck with the readiness with which the different parts of the closet admitted of being adapted to meet peculiarities of available space.

In order to facilitate the reconstruction of privies the Corporation has established works in which the wood fittings of the closets are manufactured on a great scale, and it supplies these as well as all other fittings to builders. The excrement and dry-refuse pails are furnished by the Corporation free of cost.

In the series of inspections I made with reference to the working of this new system, I had occasion first to observe the contrast as to nuisance between the dry-ash closet and the old midden closet. In several streets where the process of reconstruction had been only partially completed it was possible to compare the old and new privy arrangements in contiguous premises. It was the contrast between open, big, uncleanable cavities, containing a greater or less amount of decomposing fæcal matter, and emitting a horrible, penetrating odour, and between small receptacles emitting hardly any appreciable smell, even with the nose above the privy seat, and admitting of thorough cleansing. Most significant testimony was given to the benefit of the change by some householders. Many houses in Manchester are built in parallel rows, a back passage running between the rows, and each house having a small yard in the rear in which the privy is placed. Since the reconstruction of the privies "*it has been possible to open the back windows of the houses.*" The change, moreover, has affected

beneficially the value of cottage property, and tenants are quite willing to give 3*d.* more rent weekly since the reconstruction of the privies for the gain in decency and comfort. Soakage of excremental matter into the soil, and its passage into and accumulation in drains is, of course, obviated by the reconstruction ; and the smaller space occupied by the new closet is not an unimportant matter. The removal of the excrement pails is, with the most ordinary care, free from offensiveness, and if commonly conducted as I saw the operation, it may well be executed during the day-time, and the abomination of night scavenging done away with. The use of the cinder sifters has been adopted by householders with a readiness which proves how accurate the Corporation was in depending upon their co-operation in the working of the scheme. The high price of coal during the last two years has contributed to this good result, from the value of the cinders in economising its use. It is found, also, that a class of the population, commonly believed to be unmanageable in regard to any niceties of arrangement for excrement disposal, have rapidly appreciated the advantages of the new closet, and taken to the use of the cinder-sifter. In other words, it has been found that habits of decency and order in the particular matters referred to have been largely developed with the opportunities for such decency and order. Among the lowest class, occupying sub-let houses, and having privies used by several families in common, it will, however, probably be found necessary to adopt some special supervision, and to remove the excrement and dry-house refuse daily.

Mr. Leigh attaches great value to the deodorising effects of the fine ash. Limiting my remarks upon this subject to what I observed in the actual working of the closet, I would say that when the excrement was fairly covered by fine ash and undisturbed there was no marked odour perceptible from it. But the amount of fine ash scattered above the excrement varied very greatly according to the care given by householders, and more especially according to the times at which the ashes were sifted. Great differences were in consequence observed in the quantity of exposed excrement, and some differences in the fæcal smell. But where least care had been taken, and also where the pail contained simply the uncovered excrement of several days' accumulation, the fæcal odour was inconsiderable.

The success of the new system depends chiefly upon the completeness of the arrangements for the systematic removal of the excrement and other refuse. The scavenging, both of streets and houses in Manchester at the time of my visit was under the control of a Scavenging Committee, while the regulation of privies and ash receptacles was under the charge of the Health Committee. It was a matter of experience that the inability of the Health Committee to exercise direct control over the scavenging of excrement and dry house refuse, interposed a serious difficulty to the efficient exercise of its duties in preventing nuisance from these sources; and the Scavenging Committee had passed a resolution recommending the Corporation to transfer to the Health Committee the charge of the arrangements for the scavenging of "nightsoil" and dry-house refuse. This resolution the Corporation has since approved, and it has now been carried into effect.

Sanguine expectations are entertained that the measures adopted for the utilization of the excrement and other house refuse will ultimately go far to reimburse the Corporation for the costs imposed upon it by the new system. To whatever extent this expectation may be realized, the Corporation by directing the reconstruction of all privies of the old kind upon this new system, manifests confidence in the sufficiency of the

system to meet the sanitary requirements of the city as to abatement of excrement nuisance, and the ultimate disposal of excremental and other dry house refuse.

Halifax.

Halifax (1871, population, 65,510 ; inhabited houses, 13,970).—Few things came under observation during the inquiry conducted by Dr. Buchanan and myself in 1869 more remarkable than the arrangements for excrement disposal in this town. The midden system was that common to the greater number of houses, and was here witnessed in its most repulsive form. The chief object of our visit had been the arrangements existing in the two suburban districts of Akroydon and West Hill Park, built, the former by Colonel Akroyd, M.P., and the latter by Mr. John Crossley, M.P., as models of cottage construction for artisans. The description we then gave still applies, for, with a few exceptions, the cottages in these districts are provided each with midden-closets placed in a small yard in the rear, and constructed to contain several months' accumulation of excrement and dry house-refuse. "At "West Hill Park the ashes are thrown into an opening under the seat, "so that the excrement is well covered, and the pit is roofed in; but at "Akroydon the ashes are thrown in at a separate door, and the middens "are wet and fetid, there being no roof to the pit. At both places the "privies occupy a considerable part of the small back yard, and have the "peculiarity of being sunk two or three steps below the ground level, so "that the pit is of course deeper still. This arrangement makes the "privies less conspicuous objects from the house windows, and when "the pit is roofed flowers are occasionally grown on the top of it. But "this sinking of the privy helps the contamination of the ground by "the excrement, makes the pit more difficult of drainage, and is nowise "to be commended."

In the town newly built privies were observed, constructed according to a regulation which required each house to have its own privy, but in which the privies were placed in blocks above a common midden-stead, the privy seats being hinged so that the ashes could be thrown upon the deposited excrement. We observed of this arrangement at the time, that "it introduced the evil of the public closet without the only justification of such closets, the lessening of the area of filthiness."

The Corporation exacted a charge of from 1*s.* 4*d.* to 2*s.* per cubic yard for removing the contents of middensteads. "Halifax," indeed, as we remarked at the conclusion of our report on that town, "well illustrates "the dependence of constructive arrangements upon the public regula-"tions of the town. A charge for such emptying of a privy (even "though levied according to quantity) amounts in effect to a tax upon "frequent removal of excrement. Pits come to be constructed of the "largest available size, and their contents are retained in the hope of "making a more profitable bargain with some farmer."

Since 1869 the *Goux Patent Absorbent Closet System* has been introduced into the town, and it is estimated that about one-third of the midden-closets have been reconstructed on this system. The total number of closets in the town on the Goux system on the 19th May 1874 was 2,573. Dr. Buchanan and I had seen this system at work in Salford in 1869, and as there managed, as I have stated in my report on that town, we observed no sanitary advantage which was not to be obtained from a simple pail system. A detailed examination of the working of the system in Halifax showed, as a rule, a less degree of offensiveness to the eye than is commonly observed in the simple pail system.

The Goux system is a pail system of which the peculiarity consists in

a certain preparation of the pails and in a particular mode of manufacture of the excrement into manure, and utilization of the dry house-refuse generally. I am here concerned with so much of the system only as relates to the abatement of excrement nuisance in the vicinity of dwellings. The pail used preferably in the Goux system is of wood, of oval form, and measures 24 × 19 inches and 16 inches deep. It is prepared for use by being lined at the sides and bottom three or four inches thick with various refuse matters used as absorbents. These matters may be (to quote from a trade circular) "chaff, chopped or broken straw, damaged or refuse hay, coarse grasses, moor grass, dry street sweepings, dry horse dung and litter, sweepings of markets, hay and straw lofts, refuse wool and hair, wool, shoddy, varic or seaweed, charcoal dust, dry peat, dry ferns, spent dye woods, coal ashes, &c., any, or all of these, or their equivalents, to be mixed in such proportions as may be most convenient, together with a small per-centage of sulphate of iron or sulphate of lime." At Halifax the materials used for lining the tubs are the waste arising from the manufacture of worsted, cotton and flax, and old manure which has become dry and fallen to powder. To these materials a little sulphate of lime is added. The pails are lined with the assistance of a mould as shown in Figs. 9 and 10.

Fig. 9.

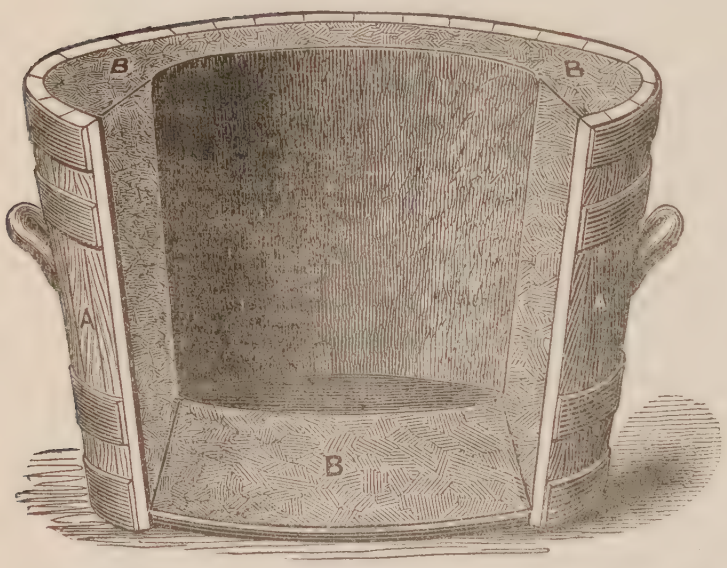


Fig. 10.

Fig. 9 shows in section an oval pail or receptacle, the bottom of which is supplied with absorbent matter at B.

Fig. 10 represents a mould (D) of a diameter less by six inches than that of the receptacle, so that the workman may raise it by the handle (E) and place it in an upright position on the absorbent bed (B), previously laid at the bottom of the receptacle.

The space (BB) which exists round the mould is filled with the same matter as that placed at the bottom.

The lining of the pail is designed to absorb the urine and other liquid which may pass into the pail, and so tend to keep the excrement drier and delay its decomposition; but absorption appeared to me to be very trivial in pails used by women and children. Widely different degrees of sloppiness existed obviously dependent upon differences in the families using the pails; but the extent of sloppiness noticed in Salford, in 1869, was rarely observed in Halifax, greater care being apparently taken in the latter town to avoid the emptying of chamber utensils into the pails. Probably the more regular locking of the doors of the closets which is practised in Halifax contributes not a little to the exclusion of the contents of chamber utensils from the pails, less trouble being experienced in casting them into the yard drain. At

any rate the aspect of the lined pails in use in Halifax generally was less offensive to the eye than of the simple pail, and the casting down of a portion of the lining, as I noticed in several instances, sufficed effectually to hide the offence and to diminish odour from the pail.

The sanitary advantages gained from the introduction of a pail system such as Goux's as compared with the midden system, in Halifax, cannot well be over-rated. The specification for the reconstruction of privies on the Goux system, which is subjoined, necessarily provides for the filling up of middensteads; and the suppression of those receptacles is an initial requisite of sound privy administration in Halifax.

Specification of Works shown on Plates XXV and XXVI. — "The outside walls to be 9-inch and the inside 4½-inch brickwork, set in lime, mortared, neatly pointed at the joints on the inside, and flush-pointed on the outside. Fill up and flag the ash-place [middenstead] with 2-inch flags, so that the same will be level with court or passage. The privy-floor to be 6 inches higher than the ash-place and the adjoining passage. Provide and fix 1¼ inch white wood riser and seat with 4¼ inch by 3 inch lintel, to back wall. Provide ¾-inch ledged door, which must be hung with bands and crooks to 4½-inch by 1½-inch frame, and secured with strong iron latch and lock with a key for each tenant. The door to the ash-place to be similar but cut in two, and each half to be hung with one pair of bands and crooks. Paint the whole of the woodwork with two coats of good oil-paint, and twice lime wash the inside of both privy and ash-pit. N.B.—The privy and ash-pit must be constructed so as to allow of the effectual removal of the refuse by the system now adopted."

The facility with which a pail-closet, such as the Goux closet, may be adopted to the requirements of old towns, is admirably shown in *Plates* XXVII. and XXVIII., prepared for me by Mr. J. R. Smith, the Sanitary Inspector of the Borough, and showing various adaptations designed by him and carried out in Halifax. I append his description of the plans given in the plates.

The Goux system in Halifax is worked by the company through the agency of its own servants. The company supplies the pails, and it receives from the Corporation for each pail-closet a royalty of 5*s*., and payment at the rate of 7*s*. per annum to the end of the present year (1874), the payment to be increased to 12*s*. if the contract be continued beyond the year. For change of the pails the company has five night-soil vans, constructed on the Rochdale pattern, with the exception of the india-rubber packing for the flaps. Each of these vans is attended by two men. It has also five carts, with eight men attached to them, for the removal of the ashes and dry house refuse. The pails are changed weekly, the exposed part of the lining of the removed pail being broken down and cast over the excrement before the pail is taken from the closet to be placed in the van. Some needless carelessness occurs in lining the pails, in their removal and cleansing, as well as in the cleansing of the night-soil vans, from want of special supervision of the working of the system by officers of the Corporation. I noticed in the course of my inspection pails imperfectly lined, and some not lined at all; pails which had overflowed from neglect to remove them at the proper time; littering of ash-place in the removal of the ashes; some splashing in van and leakage from van into street; and unsatisfactory arrangements for cleansing the vans at the wharf whence the pails are despatched to the manure works. These defects, insignificant as compared with the advantages which those parts of the town derive from the system where it has been introduced, but exciting prejudice against it, entirely arise from the want of such special supervision as the Corporation should exercise over it.

I examined two boat-loads of the filled pails. There was no perceptible odour from them under a hot sun, and I should not have had

any suspicion of their contents either from sight or smell, had I not previously known what they were. I visited the manure works of the company at Salterhebble. The manure was then being sold, I was informed, at 8*s.* a ton, for re-sale.

Halifax.

Description of Plans, Plates XXVII. and XXVIII.

"No. 1 is a block plan drawn to a scale of 24 feet = 1 inch, limiting the maximum to 12 houses in one block on the back-to-back principle of construction, and arranged for the tub or pail system of collection.

"No. 2. Arrangement selected by the Improvement and Sanitary Committees of the Halifax Corporation for recommendation, to meet the requirements of houses erected on the above-named principle, with reciprocal service, *i.e.*, upon examining plans it will be found that the night-soil tubs are withdrawn from under the closet seats at the back of the closets alternately with the ash tub designed for the accommodation of the corresponding closet on the contrary side.

"No. 3. Alternative arrangement to meet the above requirements and those of separate properties abutting on each other, without reciprocal service.

"No. 4. Alternative arrangement to meet the above requirements with reciprocal service designed for better ventilation and the prevention of offensiveness, the receptacles not being inclosed, but simply roofed over, admitting a more free circulation of fresh air than in arrangement No. 2.

"No. 5. Six closets erected for Mr. Saml. Whitehead in Whitehead's Court, Hanson Lane.

"No. 6. Six closets erected for the executors of the late John Abbott, Esquire, in Abbott's Yard, Back Clarence Street.

"No. 7. Four closets, Lilly Street, Claremount.

"No. 8. Eight closets erected for the accommodation of 24 houses belonging to Mr. J. H. Leyland in Queen Street, Cross Field, on a site originally occupied by three privies, and an open ash-pit or midden.

"J. R. Smith,
"Sanitary Inspector."

Nottingham.

Nottingham (1871, population, 86,621 ; inhabited houses, 17,911).—In Nottingham a modification of the pail system is being gradually carried out in the Old Town of peculiar interest. When Dr. Buchanan and I made inquiry as to the arrangements for excrement disposal in the borough in 1869, the use of waterclosets for the poorer classes of the population had, as a result of certain attempts to introduce them made several years before, come to be regarded as impracticable, and the efforts of the Corporation were directed to improving the construction of midden-closets and to the introduction of pail-closets under certain circumstances. A plan of midden-closet had been designed, and had received the approval of the sanitary committee of the Corporation, for securing imperviousness of the middenstead, dryness of its contents, and the proper covering of the deposited excrement with ashes and dry house-refuse, the middenstead being made of a capacity sufficient for four months' accumulation. Several privies had been constructed according to this plan at the time of our visit, but although less offensive than the common middenstead privy, they were open to grave objections. In places where space did not exist for the erection of midden-closets, pail-closets had been introduced. The pails were simple rectangular wooden boxes, receiving excrement only, and they were dealt with, either by tilting the contents into carts or by removal of the pail and the substitution for it of a clean one, daily or at intervals of two or three days, according to circumstances of use. The clean pails had a small quantity of fine coal ash or dry earth placed at the bottom before being put beneath the closet seat.

At my recent visit to Nottingham I found that comparatively few

additions had been made to the number of improved midden-closets existing at the time of the previous visit, and that the chief change made by the Corporation in the arrangements for excrement disposal had been in a certain systematic development of the pail system.

I examined several of the improved midden-closets, including some I had visited in 1869. Although in the better constructed there was some gain of decency in appearance, all were offensive and contained accumulations of filth altogether inconsistent with the wholesomeness of the surrounding premises. In the best the excrement was largely uncovered, and in the worst, notwithstanding a presumed emptying of the middenstead at intervals of three months, the ashes and dry house refuse had become piled up above the level of the opening into the middenstead beneath the seat, converting the space beneath the seat into a trough containing a large amount of decomposing excrement.

The number of pail-closets in use, all within the Old Town, was 2,510, serving for the use of 4,516 houses. This form of closet is now regularly adopted in the Old Town when a new privy has to be erected, or an old privy to be reconstructed. The arrangements of the closet differ from those I have had to describe in other towns, in that separate receptacles are not provided for the excrement and for the ashes and dry house refuse. A single pail answers for both purposes, but householders are instructed to comply with the following notice :—

Dry Closets.

" The substitution of these closets for the ordinary privy and ashpit will, if properly carried out, be a means of preventing offensive smells, which are dangerous to health. In order to accomplish this, the tenants are requested as far as possible to observe the following rules :—

" 1st. The fine ashes from fireplaces should be put into the closet tubs, the cinders and unconsumed coal should be first taken out and used for fuel.

" 2nd. All other refuse capable of being consumed, such as waste paper, straw, vegetable refuse, pieces of stick, and other like matters should be burnt.

" 3rd. Chamber slops must on no account be put into the closet tubs, but should be emptied into the sewer grate.*

" Any complaints of want of attention, or otherwise, should be forwarded to me at the municipal offices.

" Wm. Richards,
" Chief Sanitary Inspector."

In practice I found (and I believe that this is consistent with the general experience of the sanitary officials) that the bulk of the ashes and dry house refuse was thrown into the pail above the excrement, and that, in fact, each pail was a *moveable middenstead.* The structural arrangements of the closet are as simple as in the Hull system, and by substituting a pail for the space beneath the seat, as middenstead, even such slight offensiveness as attaches to the Hull system is avoided, and the facility of dealing with the collected stuff greatly increased. The freedom from offensiveness of the different pails in use examined was notable.

The pail used in Nottingham is made from half of a disused paraffine cask as at Rochdale, and a simple metal lid is placed upon it when it is removed after use. The town is divided into six districts for the change of the pails, and in every instance the used pail is removed to the town-yard for the emptying of its contents and for cleansing, a clean pail being substituted for it at the time of removal. No pail is permitted to remain longer in use than a week, and pails in use by several families

* It has been suggested that the chamber-urine should be thrown into the pail, and the house-slops down the grate.

Nottingham.

are removed at shorter intervals, and in some cases daily. The scavengers arrange their visits upon a rough approximation to the time required for a pail to become half full. The removal is effected by open waggons, a tarpaulin being thrown over the pails; and the process of changing and removing the pails is completed before 10 in the morning in summer, but in the winter it is carried on throughout the day. At the town-yard, which adjoins the canal, the contents of the pails are emptied directly into a barge; the pails are then washed out with a jet of water, and each has placed in it previously to being again put to use, a portion of deodorant powder made from mixing carbolic acid with fresh-slaked lime. The tubs are coated within and without from time to time with fresh coal tar.

Notwithstanding the increase in the number of pail-closets during the last five years, and the attempts to improve the construction of the midden-closet, the common middenstead-privy is still the predominant form of excrement disposal in the borough. The trial is now being made in a few instances of privies constructed so that the ashes are thrown upon the deposited excrement through or beneath the seat, and some restriction is being placed upon the size of middensteads, so that the area of each middenstead shall not exceed five feet square. Abundant illustration of the insufficiency of the first of these arrangements to abate middenstead nuisance, unless combined with smallness of receptacle and frequency of cleansing, will be found in other parts of this report; and the proposed degree of limitation of the size of the middenstead, while, perhaps, diminishing some existing nuisance, will leave the essential evil of the middenstead system—improper accumulation of filth in the vicinity of dwellings—untouched.

Nottingham readily gets rid of its midden-closet and pail-closet refuse. Both are as a rule in regular demand for farms in the vicinity of the borough, and along the line of canal. At the wharf the midden-closet refuse sells at 2*s.* a ton, and the pail-closet refuse at 3*s.*, exclusive of carriage. When deposited in the barges the refuse from the slaughter-houses and markets, and some stable manure are added, also urine collected from the public urinals. A store of street sweepings is kept in the yard to obviate any sloppiness of the contents of the barges. In 1873 the total refuse removed from the town (exclusive of street sweepings) was 32,619 tons, of which 31,926 tons consisted of nightsoil and ashes. The total cost of this removal was 8,269*l.* and the receipts for the sale of manure (including charge for carriage) amounted to 3,956*l.*

Leeds.

Leeds (1871, population, 259,212; inhabited houses, 55,827).—I had occasion early in 1871 to describe the condition of the borough of Leeds, at the close of 1870, with regard to its arrangements for excrement disposal. At that time there were in the borough 30,335 privies communicating with 13,500 middensteads (or "privy-sumps"), 6,348 waterclosets, of which several were tumbler-closets, 277 pail-closets, and 4,500 dry ashpits. The pail-closets were the remains of a system begun in 1863 with the hope of manufacturing profitable manure from the excrement, but which had not been approved by the Corporation.

I then wrote* of the middenstead system in Leeds as follows:—"The "common privy with middenstead is, in fact, still the ordinary pro- "vision for excrement disposal of the great mass of the population, as

* Report on the sanitary state of Leeds, with particular reference to Diarrhœa and Fever, 1871.

"well of the town as of the borough outside the town. Although long "recognised as the filthiest and most unwholesome mode of excrement "disposal, it is not only retained in Leeds, but it is perpetuated by the "building laws of the Corporation in its most objectionable form. . . . . "The greater numbers of the privies and middensteads in Leeds were "built at a time when either there was no public provision for their "being cleansed, and the householders were dependent for this process "upon the convenience or necessities of farmers, or when such public "provision as existed was without any systematic regulation or super-"vision. As a consequence it was necessary that middensteads should "be constructed of so great a capacity as to contain many months' "accumulation of filth. These receptacles, dug several feet into the "ground, are, as a rule, lined and built in with walls of highly porous "brick, and the bottom is either paved with brick or flags, or, as is not "uncommonly (perhaps more generally) the case, it is formed by the "natural soil. Some are gulfs so vast that an individual falling acci-"dentally into them, if aid be not at hand, may readily lose life."

The scavenging of middensteads within the town of Leeds and the suburbs of Holbeck, Hunslet, and part of New Wortley, was, in 1871, carried out by servants of the Corporation, under its direct control. In the rest of the borough this scavenging was effected by owners and occupiers at their own cost, subject to the supervision of an inspector of nuisances for each township. Here the scavenging was regulated solely by the fulness of the middensteads and the convenience of the owners and tenants; and nuisance in respect to the receptacles was interpreted as overfulness, and the additional abomination apt to arise therefrom.

Of the cleansing of the middensteads within the district scavenged by servants of the Corporation I had to say:—

"The work is not performed systematically street by street, in definite order, throughout the sub-districts. It is regulated—(*a*) by notices received from householders requiring the cleansing of their middensteads; (*b*), by information received from the inspectors of nuisances; and (*c*), by the observation of the inspectors and foremen of scavengers and their men. The inspectors and foremen arrange the day's work of the carts, in accordance with the information received from the different sources mentioned; and if this be not sufficient to occupy the whole staff, the spare carts and men are sent to the *worst-known* places, irrespective of notices. The scavengers work during the night, and, on an average, 120 middensteads and ashpits are cleansed nightly. The number of middensteads and ashpits within the scavenging districts is 11,500; and if these were scavenged systematically, at the rate compassed by the present staff, they would be emptied about four times in the year. This would be the best result that could follow from the present regulations of the staff. But, practically, the result must fall far short of this; for the greater part of the scavenging is made conditional upon the convenience of householders, and the amount of provision they possess for the storage of refuse. The existing arrangements, indeed, are sufficient to prevent larger collections of refuse than the receptacles provided for it will contain; but they entirely fail to effect so great a reduction of the excremental filth and other refuse, commonly stored in the vicinity of dwelling-houses, as is needed to affect in any sensible degree their noxious influence upon the health of the inhabitants."

Subsequent to the publication of this report the Corporation again instituted an experimental trial of a pail system of excrement

removal within a limited district; and since May 1 of the present year (1874) it has caused certain important modifications to be made in the cleansing of middensteads within the area scavenged by its own servants. In other respects the state of Leeds as to its middenstead-privies remains as I described it in 1871, and, except in the limited district referred to, no change has been made in the construction of middensteads.

The *pail system* has been introduced into a district (the East Ward), which contained 1,506 privies and 699 middensteads for the use of a population of 15,000. From the time of introduction to February last, 690 of the middensteads had been filled up, and 1,484 of the privies converted into pail-closets. I have had an opportunity of inspecting parts of this district twice during the course of the alterations. The middenstead privies in the district were among the very worst and most offensive in the borough, and the change effected by their removal and the substitution for them of pail closets is remarkable. The absence from the East Ward of the penetrating midden stink which is so characteristic of Leeds, even in well-to-do parts, is especially noteworthy. The pail system, as first adopted, consisted in the removal of the pails from the closets weekly, and the substitution of clean pails for them. Each pail before being used had been cleansed in the Corporation yard, and a quantity of carbolate of lime placed in it. When removed from the closet a lid was placed over it, and it was carried away in a closed van. As managed complaints quickly arose of sloppiness in the closets, and scattering of contents in the passage of the pails to the vans and through the streets, and much nuisance therefrom. Eventually this arrangement was given up and under the advice of Dr. Goldie, the present medical officer of health, another mode of working the pail system has been adopted.

The causes which, so far as I can gather, appear to have led to this failure of the pail system, as carried into operation at the outset, have been as follows:—first, there was a want of due proportion between the number of pails and the number of families using them, or between the frequency of removal of the pails and the rate at which they filled. The pails adopted were of the capacity used in Rochdale for a single family during one week. In Leeds a pail would frequently serve for the use of several families, and, as a consequence, its contents not rarely overflowed or were liable to be spilled in part during removal. To avoid this evil the pail closets should have been increased in number, or the removal of the pails should have taken place more frequently.

The pail system, as now worked in the East Ward, Leeds, comprises a *daily* emptying of the pails, without changing them, and the use of fine coal-ash to cover the deposited excrement. The use of the fine coal-ash is simply an instruction to householders, and is at present carried out very irregularly. Many houses in the East Ward have ash-pits before the fire-range, into which the fine ash is raked and the cinders separated for re-burning. These ash-pits are only emptied at intervals, usually of a week, and then only in these cases is the fine ash cast into the excrement pails. In an examination of many pails which I made, it was the exception to find ashes above the excrement. The contents of the pails when removed are merely tilted into the nightsoil cart, and the pail is then scraped, sprinkled with carbolate of lime, and replaced. The stink from this process is much less than the description would imply, and incomparably less than the stench from emptying a common middenstead.

The nightsoil scavenging is conducted between the hours of 11 p.m. and 6 a.m., and I made an inspection both of the mode of

emptying the excrement pails and of the ordinary mode of emptying middensteads. Anything more offensive than the process of emptying an ordinary middenstead, particularly when it is sloppy and shut in beneath houses, I cannot conceive. The process is necessarily limited to the night hours; but that the necessity for it should exist in a borough like that of Leeds, I can only explain on the supposition of the absolute ignorance of its nature on the part of those who are responsible for its continuance.

The present mode of working a pail system in Leeds, had been too short a time in operation at the period of my inspection to admit of a definite conclusion being formed as to its particular merits, except with regard to the *daily* cleansing. The enormous advantage gained by this frequent removal of filth, as compared with the old midden-system, is incontestable. Under this system the ashes and dry-house refuse are collected by a separate set of men and carts during the day.

At the suggestion of the superintendent of the sanitary department, Mr. Newhouse, since the 1st May last arrangements have been made for systematically cleansing middensteads and ash-pits by street-row. With some increase of the scavenging staff, this, it is believed, may be effected throughout the district scavenged by the Corporation every six weeks.

The four years' work of the Corporation in regard to excrement disposal since my inspection in 1870, may be summed up as follows:—*One sixteenth* (16,000) of the population of the borough or thereabouts, has a pail-system with its great advantages. Not more than six weeks' filth will probably now be permitted to accumulate among *twelve-sixteenths* (192,000), the manner of accumulation remaining unchanged. The state of the remaining *three-sixteenths* (48,000) as to its filth receptacles and the storage therein is unaltered.

Forty-three tumbler-closets are now in use in Leeds. No addition has been made to this number during the last three years. This form of closet is, in fact, now discountenanced, as wasteful of water and difficult to keep in order. In 1870 I found that the regulation of the water supplied to these closets, the control of which is under the Water-works Committee, was not conducted on any definite principle, and that the supply was in several instances quite insufficient for the proper working of the closets. This cause of defective action of tumbler-closets still continues. Further experience has shown, moreover, that the pivot of the tumbler is apt to get out of order, and experiments with pivots formed of various materials have not succeeded in remedying this defect. Finally, much difficulty has arisen from ashes and other rubbish thrown into the trough of the closet.

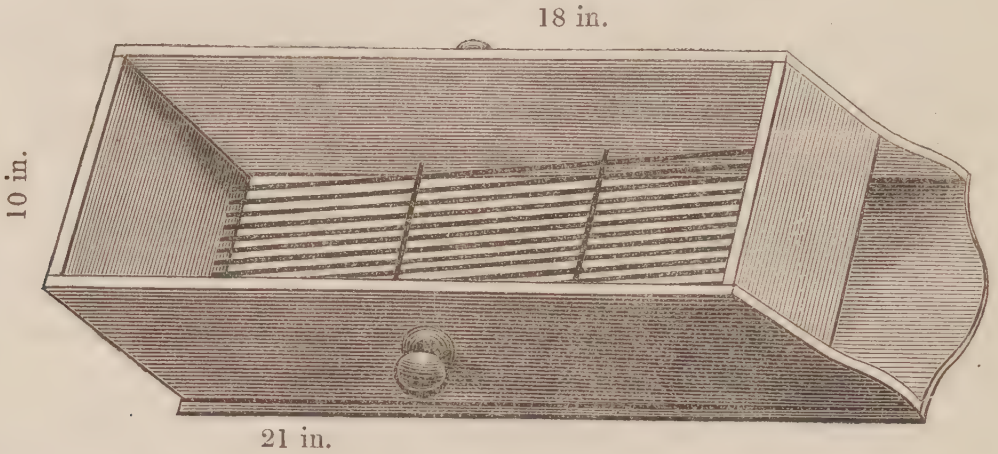
I subjoin a drawing of a tumbler-closet. (Plate XXIX.)

Cockermouth.

Cockermouth.—In the district of the Cockermouth union rural sanitary authority, I had the opportunity of witnessing the beginning of an interesting and important experiment in excrement disposal which is being carried out by the authority. On the advice of their medical officer of health, Mr. John Makinson Fox, it is seeking to familiarise the rural population with the use of a pail closet, independently of any arrangements for cleansing and dealing with the contents of the pails by the sanitary authority. Part of the scheme is to secure the covering of freshly-deposited excrement with fine coal-ashes, with a view of obviating nuisance from it and of better fitting it for subsequent use as

manure. To these ends Mr. Fox has invented a cheap and handy cinder-sifter (Fig. 11), which may be used above the aperture of the

Fig. 11.



closet seat. This sifter, to meet local habit, is also designed for a "trug," the Cumberland term for a dust-box, an article of furniture found in every house.

In furtherance of this experiment and otherwise to provide for improved privies and the abatement of privy nuisance, the sanitary authority (having previously been invested with certain urban powers) has included the following regulations in its byelaws, made under 21 & 22 Vict. c. 98. s. 34, and sanctioned by the Local Government Board on the 9th July in the present year (1874):—

"1. The person constructing any privy and ash-pit in connexion with any new buildings shall construct such privy and ash-pit at a distance of not less than ten feet from any part of any house.

"2. The person constructing any ash-pit or midden privy shall cause the floor and sides of such ash-pit or privy to be cemented or constructed of non-porous materials so as to prevent infiltration into the soil.

"3. The person erecting any privy, may, in lieu of any ash-pit and midden privy constructed as above, provide pails according to the following arrangements:—

Every such privy must be constructed with hinges at the back of the seat, that the seat may be raised for the use of the cinder sifter and removal of the pail.

Every house must be provided with a dust box and cinder sifter for the daily covering of the nightsoil with dry ashes from the fire or with dry earth.

"4. The person constructing any privy or ash-pit shall cause it to be placed in a convenient situation, to be constructed with proper materials and of such a size as shall provide adequate accommodation for the premises.

"5. He shall cause the same to be provided with an opening as near to the top as practicable, communicating directly with the external air, or to be otherwise furnished with sufficient means of ventilation.

"6. He shall cause such ash-pit to be roofed in, and to be provided with a side door one yard square."

The sanitary authority has also issued the following special notice with respect to the use of the dust-box and cinder-sifter:—

"Cockermouth Union Rural Sanitary Authority.

"*Dust-box and cinder-sifter for disinfection of nightsoil.*

"Every privy must now be kept, according to the statute so as not to be a nuisance and injurious to health.

" A privy is a nuisance where the nightsoil is allowed to accumulate, or where it is not covered, disinfected, or removed, every day.

" A pail for the reception of the nightsoil is better than the old pit privy.

" The dust-box and cinder-sifter is intended to accomplish the purpose of disinfection with the least possible trouble and expense.

" This box combines the purposes both of a dust-box and cinder-sifter.

" It is to be used every day.

" Each day the ashes and cinders are to be placed in the box on the wire floor.

" The box is then to be taken to the privy, and shaken over the pail.

" The projecting end of the floor is to be placed within the sides of the pail, and after shaking the box, the ashes only will fall upon the contents of the pail.

" The cinders remaining upon the iron floor, may be taken back to the fire or removed to the coal-place, or placed in a separate receptacle for cinders.

" *If the cinders and other house refuse are placed in the pail, they will deprive the whole of its contents of any value.*

" The pail when full, will either be removed by the township, and an empty one left in its place ; or the contents may be used in the garden as manure.

" In every case, where there is a difficulty of removal, notice should be given to the inspector.

" It is important that the ashes should be thus used every day. The habit then becomes easy.

" *By this means an infectious and offensive smell will be destroyed, sickness prevented, coal will be economised, and a valuable manure will accumulate for the ultimate benefit of ratepayers.*

" John Makinson Fox.
" Medical Officer of Health to the Authority.

" John Musgrave,
" Clerk to the Authority."

In addition to the foregoing instructions, the inspectors of nuisances are directed to report as nuisances privies in which no attempt is made to keep the excrement covered with ashes or dry earth.

Previous to the constitution of the sanitary authority, pail closets had been introduced into various parts of its district by private enterprise, and the efforts to bring them into more general use have thus been facilitated. The total number of pail closets in the district at the time of my inspection was 360, and of these 163 had been constructed at the suggestion of the sanitary authority.

In the several instances I examined in which pail closets had been substituted for the old middenstead privy, the cottagers had not failed to appreciate the greater orderliness and slight offensiveness of the former, as compared with the latter. They recognised the advantages of getting rid of the abiding stink of the old privy, and of having under control any stink which might come from the new privy, if they would take the trouble to sift their ashes over the pail. An incidental inducement to take this trouble was confessed by some, it may be noted, in the high price of coal, which made the recovery of the cinders from the ashes a matter of some consideration. Where cottagers have gardens, little difficulty appears to be experienced in managing pail closets, as it is possible to store the contents of the pails, harmlessly, it is believed, until they can be used as manure, for which purpose they are held in high esteem. In the comparatively few instances where cottages have not gardens, if pail-closets be adopted, it will be necessary to make arrangements for the removal of their contents with neighbouring farmers or possessors of gardens. Each case of construction or reconstruction of a privy on the pail system is, however, being dealt with on its own merits, the object being kept in view, in carrying out the change, to endeavour to effect it mainly through the agency of the

Cockermouth.

people themselves. Proprietors of cottages who have adopted pail closets in connexion with them, have in some instances undertaken the removal of their contents. One instance was mentioned to me of 50 cottages having pail closets, attached to a manufactory, of which the proprietor removed the contents of the pails at intervals to a farm he possessed.

If, as seems not improbable, the success of the experiment undertaken by the Cockermouth union rural sanitary authority should in certain cases, be interfered with by obstacles in the disposal of the contents of the pails the sanitary authority proposes to overcome these obstacles by some supplementary action.

Birmingham.

Birmingham (1871, population 343,787 ; inhabited houses, 68,532).—When Dr. Buchanan and I visited Birmingham in 1869, the Corporation had no detailed information of the arrangements for excrement disposal in the borough. Except in better-class houses, midden-privies were in common use, but neither the number nor the structural disposition of the latter was known, and their construction was not subjected to any systematic rule. No byelaws existed regulating the erection of privies or ashpits in new houses, and although plans of new buildings and their appurtenances had to be approved by the borough surveyor, he interfered with the privy arrangement only so far as to require the provision of a drain from the privy pit. For the rest, a builder might as a rule build privies on any plan that suited him uncontrolled by the authorities. There appeared to us, therefore, as we observed in our report of this visit, "No prospect of rapid improvement "on the filthy state of things that exists throughout the poorer parts of "the town."

In 1871, the Corporation appointed a Committee of Inquiry on the best mode of disposing of the sewage of the borough. This committee, presided over by Mr. Alderman Avery, devoted three months to the inquiry, and prepared a detailed report of remarkable interest, which has been published as an independent work.* In the summary account of the results of the inquiry which precedes the report, the Committee state that :—

"The extent of the midden system is now for the first time ascertained. There are in Birmingham 3,884 premises containing 7,065 waterclosets, accommodating about 20,000 persons ; and 70,000 houses connected with 19,551 privies and middens, accommodating about 325,000 persons. Of these middens or ashpits, nearly 14,000 are drained into the sewers. The middens cover an area of 16,170 square yards, or about 13½ acres ; and practically all of them, containing fæcal water, and solid and liquid refuses are open to the air. Some of them are situated beneath houses or workshops, and large numbers are built against the walls of houses, which are thus permeated with the filthy liquid making through the walls. The consequence is that the sewers are constantly fouled by the drainage from the middens, and that the surface wells gradually become the receptacles of sewage matter, with which the earth surrounding the middens is absolutely saturated." (p. xi.)

The Committee recommended in regard to the midden-stead system, and as part of a plan of excluding almost all excremental matters and trade refuse from the sewers :—

* Borough of Birmingham.—Report of the Sewa e Inquiry Committee, 1871. Simpkin, Marshall, & Co.

(*a*.) "The gradual abolition of middens, and substitution of a new "privy system, based upon the principle of exclusion from "the sewers, and weekly collection of all excrementitious "matters solid and liquid." (*b*) "An experimental trial of "the Rochdale and Manchester systems on a sufficiently "large scale, and under the strictest supervision, and "ultimately an extension to the whole town of that system "which shall be found to be the most efficient." (*c*) "The "imposition of a rate on occupiers in respect to water-"closets connected with the sewers on a scale to be "sanctioned by the Council."

The "Manchester system" referred to above is not the system described in this report, and now adopted in Manchester, but the system of improved dry privies described in the report of Dr. Buchanan and myself in 1869, and which has since been given up for the pail-system now in process of being introduced generally throughout that city.

In May 1873 an experimental trial of a pail-system, founded upon the Rochdale system, was begun in Birmingham, and at the time of my recent visit 2,700 pail-closets had been constructed in the borough. No compulsory power is exercised by the Corporation in the introduction of these closets, but byelaws are in preparation for their regulation. The Corporation has directed their introduction in new houses where no objection is offered by the owner, and has encouraged their substitution for midden-privies when these have required reconstruction. But it is optional with the owner whether he adopts the pail-closet, the midden-closet, the ordinary watercloset, or a form of trough-closet which has been erected in a few instances. So rapidly, however, is the pail-closet gaining favour with property holders that the present limited means which the Corporation possesses of carrying out the experiment is taxed to the uttermost. This has arisen mainly from want of yard space in which to deal with the collected matters, and pending this difficulty being overcome it has been found necessary to discourage the alteration of midden-closets into pail-closets.

The pails are changed weekly, the clean pail having a portion of antiseptic in it prepared after the Rochdale plan. The arrangements of the Corporation, indeed, generally as to the collection of the excrement pails and dry house refuse, and subsequent manufacture of the excrement into manure and utilization of the refuse follow the Rochdale system as closely as their provisional nature admits. The manure made from the mixed excrement and fine coal-ash sells at 5*l*. per boat-load of from 24 to 25 tons, and has even commanded a price of 7*s*. a ton. Of the sanitary advantages of the system, as marked by its freedom from nuisance in comparison with the middenstead system, there can be no question ; and it is beginning to be perceived that the net cost of the working of the pail-closet may be much less than that of the midden-closet, as has been shown at Rochdale. A prospective advantage of the extension of pail-closets in the borough, mentioned to me, was the probable utilization in the manufacture of manure, of a vast and accumulating deposit ("tip") of middenstead refuse which exists 10 miles from the town. The excrement pail used in Birmingham differs, especially in the arrangement of the lid, from the pail commonly used in Rochdale. It is of galvanized iron, and is of the dimensions and form shown in *Plate* XXX.

During the inspection I made of many of the pail-closets erected in Birmingham, I noted the same freedom from offensiveness which I remarked in the inspection of similar closets elsewhere. But in Birmingham, for the first and, indeed the only, time during the recent

inquiry, a complaint was made to me of greater offensiveness from pail-closets than from midden-closets. This happened in No. 2 Court, Ward Street, in which an excellently constructed block of pail-closets had been erected. There was certainly more odour within the closets than I had before experienced; but I satisfied myself that this arose from insufficiency of through ventilation of the closet. A neighbouring block of pail-closets (No. 4 Court, Ward Street) constructed in the same style, but much more freely ventilated, was free from the odour which existed in No. 2 Court. I shall elsewhere have to refer to defective through ventilation as favouring a certain degree of offensiveness in earth-closets otherwise fairly managed.

In addition to the introduction of pail-closets, an important change is being made in the cleansing of middensteads, and which is to be regarded as the first step to their systematic scavenging irrespective of notice from householders. The borough has been divided for the purpose of night-soil scavenging into six districts and 36 sub-districts, and arrangements are now made that the applications for the cleansing of middensteads from each sub-district received during the day shall be dealt with during the night following.

The applications to the night-soil department for the cleansing of middensteads and ashpits in 1873 amounted to 26,518, of which 5,826 were received from the inspectors of nuisances. Altogether 27,644 were cleansed in the course of that year, and 163,142 loads of stuff removed. The cost of this cleansing was 24,000*l.* less 3,500*l.* received for the sale of part of the removed material. It is estimated that the cost of working the pail system in the borough, including interest on capital account and depreciation, would not exceed the cost of the present night-soil scavenging by more than 2,000*l.*, while the receipts from the sale of manufactured manure and rough ashes would probably realise 18,000*l.* This estimate does not, however, appear to include the cost of the manufacture of the excrement into manure.

I examined one of the trough-closets referred to in a previous paragraph. The closet in question is in No. 8 Court, Hospital Street. Four closets here, used by 12 families, communicate with a common trough which is designed to be flushed by slops and the rainfall falling in the court. The bottom of the trough was covered with a thick layer of excrement and paper, and the sides were lined with excrement. The stink from the closets was most offensive, and a considerable up-draught through the seats appeared to come from the sewer.

Warrington.

Warrington (1874, population 32,144, inhabited houses 6,044).—The Corporation of Warrington has adopted a pail system of excrement disposal, and is now steadily carrying it out in the borough in new houses, where waterclosets are not adopted, and in the reconstruction of old privies. At the time of my visit to Warrington, in October last, 1,157 pail-closets had to that time been constructed and were in use. Generally the Rochdale system is followed in regulating the pail-closets, but with certain noticeable modifications. The excrement pails are of wood, as at Rochdale, but made, as well as the ash-tubs, on the Corporation premises. The arrangement of the lid is, however, different: first, a piece of canvas is placed over the mouth of the tub, and this is held in place by a circular wooden lid. Then the mouth is closed by an outer metal lid with flange. The pails, after being emptied and washed, have the interiors brushed with a brush made for the purpose, and saturated with a disinfectant, of which also a ladleful, measuring a gill in quantity,

is placed at the bottom of each pail before it is again used. This disinfectant is made from the following formula :

Sulphate of iron - - -	4 lbs.
Sulphate of zinc - - -	1 lb.
Chlorate of potash - - -	2½ lbs.
Hydrochloric acid - - -	2 lbs.

Water to 40 gallons. Mix.

In the construction of the closets, preference is given to a pent-house, beneath which to place the ash-tub.

Salford.

Salford.—The borough of Salford has not yet emerged from the experimental stage as to excrement disposal, in which it was found by Dr. Buchanan and myself, when we visited it in 1869. At that time, here as in Manchester, the Corporation was seeking some way of permanently abating the nuisance arising from the many middenstead privies in the borough, then with certain exceptions presently to be mentioned, numbering 21,642, and serving, together with 1,500 waterclosets, for 25,555 houses; now, with similar exceptions, numbering 26,184, and with no greater quantity of waterclosets, serving for 29,423 houses. The byelaws of the Corporation required that every dwelling house should have at least one watercloset or privy, and that "every privy should be "placed outside the dwelling house, and should have an opening to the "external air, near the top thereof of at least 12 square inches, and the "receptacle for the soil should be separated from the wall of the dwelling "house by a space of at least 3 feet, and should have a drain therefrom, "to, or to some drain communicating with, the sewer in the adjoining "street or court, and should be so constructed as to prevent nuisance." By a resolution of the health committee of the Corporation, the building sub-committee had been instructed to require that all ash-pits (middensteads) to new buildings should be made of a *minimum* size of 3 feet by 4 feet 6 inches; and in respect to old constructions, the Corporation by virtue of powers possessed under the Salford Borough Improvement Act could require alteration to the same type to be made.

While the privies of new houses were generally being constructed according to the byelaws and the resolution of the health committee, two experimental methods of excrement disposal had been put in operation by the Corporation, chiefly in parts of the borough where privy nuisance was greatest, and involving reconstruction of existing privies. One of these methods was an improved form of middenstead-privy, a "dry privy," so called; the other was a pail-privy, managed upon a particular plan, and designated, after the inventor, *Goux's Patent Absorbent Closet System.*

The dry privy consisted of a water-tight receptacle beneath the seat, into which was intended to be thrown, through an aperture, beneath a step ("the tread"), attached to the "riser" of the seat, the ashes and dry-house refuse, so as to cover the excrement. The seat was hinged, so that it could be thrown back, and the floor made movable, to admit of the receptacle being cleansed. A ventilating flue was carried from the upper part of the receptacle several feet above the roof of the privy. About 200 privies of this pattern had been constructed at the time of our visit. We inspected several, and as we then reported, "except where a closet was locked, and its use restricted to a "single family, or at the most two or three families, we found them in "a most unsatisfactory state." In the cases where privies of this kind were used by several families, we found the aperture beneath "the

tread" more or less choked, the floor littered with filth, the litter extending about the doorway, and the excrement largely uncovered. They were, in fact, almost as offensive as the privies for which they had been substituted, and were not less filthy in their surroundings. The result of this experiment has not been such as to induce the Corporation to approve of the multiplication of these privies. Several of those constructed at the time when Dr. Buchanan and I visited Salford remain. I re-inspected a few, and their state confirmed the opinion formed upon them in 1869.

Of Goux's Patent Absorbent Closet System, as seen in operation in Salford by Dr. Buchanan and myself, we reported as follows :—

"We inspected many pail-closets used by single families, and others used by several families, or by the inmates of a common lodging-house. In every instance where a pail had been in use over two or three days, the capacity of absorption of the liquid dejections, claimed by the patentee for the absorbent material, had been exceeded; and whenever a pail had been four or five days or a week in use it was filled to the extent of two-thirds or more of its cavity with liquid dejections, in which the solid excrement was floating. The contents, in fact, differed nowise in aspect, except in the cases where a portion of the dyewood lining had broken down and fallen into the liquid, from what we should have expected if a simple unprepared pail had been used. It was suggested that a part of the sloppiness of the pails probably depended upon the fact of chamber pots having been emptied into them ; but although the regulations for their use permit this to be done, we did not always find on inquiry that even this source of wetness had been in operation."

The subsequent experience of the system has not induced the Corporation to continue it, partly because it did not appear to yield any sanitary advantages over a simple pail system, partly from a distrust of the economic results to be obtained from it in the manufacture of manure. This manufacture, it is proper to add, was carried out as a matter of private enterprise, and not by the Corporation; and the method differed in some details from that proposed by M. Goux. The manufacture did not prove a commercial success, and with its cessation the use of the Goux system also ceased.

I have given a description of this system in my account of Halifax, in which town it has been put in operation somewhat extensively. Here results were observed, during the recent inspection, more favourable to the working of the system than had been witnessed in Salford in 1869, and more in accordance with the statements of the projector.

The privies which had been re-constructed in Salford for the Goux system, about 2,000 in number, are now used as simple pail-closets, the pails being changed weekly, or as often as required. The van used for their removal is constructed after the Rochdale pattern. The contents of the pails are mixed with middenstead and other refuse which can be used for manure, except a portion that is put at the command of a company, The Universal Charcoal and Sewage Company Limited, which, by permission of the Corporation, is carrying on certain experiments in manure manufacture in the municipal scavenging depôt, or "Town yard."

The Salford Corporation, dissatisfied with the results of the experiments as to excrement disposal which it had already instituted, is still carrying out, or permitting to be carried out, other experiments. These experiments, however, do not appear to be undertaken upon a definite plan, or with any clear conception of the principles which should govern

the removal of filth from the midst of a community. They seem rather to be the expression of irregular impulses, and from the mere multiplication of methods, their tendency is more to complicate than to simplify the difficulties besetting the subject. Meanwhile middenstead-privies of the old, offensive type still enormously preponderate, and even are increasing in number. For the middenstead-privies commonly constructed under the byelaws, differ too little in actual harmfulness from the privies of the old type to be dissociated from them.

In addition to the pail-closets and dry-privies already referred to, I observed, during the recent inspection: (1) A so-called modified midden-closet, of which, although it was roofed and built with some care, it is sufficient to say that it was specially constructed to hold from three to six months' excremental and dry-house refuse of the families using it, and thus limit the necessity for cleansing to those periods. This form of midden-closet, in fact, exhibited an actual adoption of the evil which it should be a principal object of the Corporation to remove, namely, the evil of large accumulation of filth in the vicinity of dwelling houses.* (2) The Manchester plan of dry-ash closet, in a few instances. (3) Another form of dry-ash closet (Morrell's). (4) A so-called "self-acting watercloset."

The closet, known as *Morrell's Patent Ash-Screening Closet*, now the property of a particular company (*the Sanitary and Economic Manure Company, Limited*), has been recently adopted, by direction of the sanitary committee of the Pendleton district of the borough, in upwards of 300 houses. This closet was one of the earliest invented of the dry-ash closets, and examples of it were seen by Dr. Buchanan and myself in operation in Manchester in 1869, but not under conditions which would admit of our forming a judgment as to its general applicability to a civil population. The dry-ash closet now adopted in Manchester is formed essentially upon the same principles as Mr. Morrell's closet. His closet differs from the Manchester closet in the mechanism for distributing the fine-ash over the excrement, and in the absence of means of ventilating the space behind and beneath the seat; but the objects it is designed to answer are the same. I give Mr. Morrell's own description of the arrangements of his closet, taken from a paper read by him before the National Health Society.

Description of Morrell's Combined cinder-sifter and ash-closet.

"The system which I advocate," he says, "provides for the perfect separation of the *ashdust* from the *cinders* by means of a screen or sieve of galvanised woven wire placed at the rear or side of the ordinary closet into which house ashes may fall by being simply thrown, as now, through a hole in the wall. Attached to this screen are parts which form a hopper for receiving the ashes. This screen and hopper, forming one, are connected by a simple lever arrangement to the seat of the closet, or by a foot treadle in front of the seat in such a manner that, when the closet is used, an agitating motion is given to the screener by which the cinders are made to fall down the incline, the ash dust dropping through into the hopper below, and thence into a small receiver from

* The following note attached to the detail drawing of this modified privy, issued by the Corporation, sufficiently describes the structure:—

"The ashpit to be made with the bottom 1 ft. 2 in. below the level of the passage, and with a fall of 6 in. from under the seat. A well-hole under the ashpit, to be built with bend pipe as shown, and properly connected with sewer. The ashpit to be roofed in and well ventilated. The floors of the ashpits to be 3 in. Rochdale flags, laid on concrete. The privy seat to be hinged to turn back, so as to allow ashes to be thrown over the soil. Openings to be made on the yard side 2 ft. by 2 ft., for the ashes to be thrown into the ashpit. A door, 3 ft. 6 in. by 2 ft., to be placed on the passage side for the purpose of emptying the ashpit. The whole to be finished to the entire satisfaction of the medical officer of health" [who, however, it is proper to add, disapproves wholly of the structure].

which it is meted out in the exact quantity required over the recent dejection, when the seat is vacated. Thus the ash dust is by this simple, self-acting contrivance separated from the cinders, and on each use of the closet is made to serve as a sanitary agent by arresting the decomposition of the fæcal refuse, the cinders being thrown simultaneously on to the coal heap, or on to the floor, or into a box for re-consumption at the house fire.

Material which may be added.

" House sweepings, dried earth, or any other dry material may be thrown in with the ashes, as the screener rejects all the portions unsuited for use in the closet.

Receptacle for soil.

" The receptacle for the soil may be a moveable vessel or a fixed water-tight trough. In general practice my impression is that a fixed trough made of a small capacity, corresponding, say with the size of the seat in length and breadth, and of about 1 foot to 2 feet deep, and emptied at one end, will prove the most serviceable and efficient. The application of this arrangement to existing structures is best accomplished by filling up the cess or ash midden to the level of the surface with (in case the small vault is used) the exception of the space it will occupy below the seat.

Space occupied.

" The total space, then, occupied will be an addition to the privy proper, but only by as much as is taken up by the screener, which will usually be found to be much less than that occupied by the old ash-midden. For new erections the total space absolutely necessary need not exceed 6ft. by 2 ft. 6 in., but these dimensions can be extended if larger premises are preferred.

Application for access from interior of house.

" If it is desired to apply the system so that the closet can be entered from the inside of the house, the screening portion of the apparatus can be placed as a projection from the external wall, and be accessible for charging with ashes from the outside. In this case the privacy of the closet proper is preserved, and all the advantage of the internal earth-closet secured, whilst the cinders are thrown for collection outside and the vault emptied, or the soil-pan removed from the outside."

I inspected several of these closets in operation in Pendleton. They presented all the cardinal advantages in the diminution of privy nuisance which I had occasion to observe in the Manchester dry-ash closet. The stink and the porous middenstead were got rid of; the accumulation of filth was brought within a small compass; and nuisance from the freshly-deposited excrement was obviated by the fine ash cast upon it. The closets had been too little time in use to enable me to form an opinion on the comparative merits of Mr. Morrell's arrangement and the Manchester arrangement for screening the ashes.

The "self-acting watercloset" which has been referred to is a form of closet designed and patented by the borough surveyor, Mr. Alfred M. Fowler. It is now being somewhat largely adopted in the town of Salford. This closet is arranged to be flushed by slop and waste water without the use of town's water. The closet is formed by fixing a trapped pan at such a level that the waste water from the sink, the slops from the house, and the rain water from the roof are carried by a covered drain into the trapped pan. A very similar arrangement exists in some of the Bristol privies, and it appeared to me that the conditions for the successful working of Mr. Fowler's closet would be found to be the same as for the Bristol privy, namely, frequent systematic inspection; the sanitary authority being prepared to cleanse, and undertaking the cleansing of the privies where necessary; and a plentiful and readily accessible supply of water.

I give drawings (Plate XXXI.) showing a section of Morrell's closet as applied in McCleary St. Pendleton (Salford), also a section of the privies for which Morrell's closet has been substituted.

The Universal Charcoal and Sewage Company, Limited, to which reference has been made as carrying out certain operations in the Salford Town Yard, has patented a process for manufacturing charcoal from *street sweepings*. It proposes, while fully utilizing a form of refuse often most difficult to be got rid of at a loss by local authorities, to

provide a charcoal fitted for all sanitary and some other large purposes to which charcoal can be applied, at a cost considerably less than the ordinary charcoals of commerce. The charcoal mixed with nightsoil is said to form a valuable manure, and manure is being manufactured in this way by the Company in the Salford "Town yard." I shall have to refer to the operations of this Company again, when I describe the charcoal process of excrement disposal.

Salford.

Oldham.

Oldham (1871, population, 82,629 ; inhabited houses, 16,739).—The Corporation of Oldham has adopted a pail system throughout the municipal borough. When Dr. Beard inspected the borough in 1872 the then existing arrangements for excrement-disposal consisted of 1,300 water-closets, 1,800 pail-closets, and 6,200 midden-closets of the old offensive type. Now, less than 50 midden-closets remain in the borough, and for the remainder pail-closets have been substituted. At the time of my visit to Oldham, the Corporation had entered into an agreement with the Carbon Fertilizer Company, Limited, by which the Company on payment by the Corporation of 3*s.* per closet, exclusive of closets attached to mills and workshops (the scavenging of which is conceded to the Company free of charge), undertook the collection of the pails and the disposal of their contents. The Company, I was given to understand, proposes to use charcoal in detail for the different closets, as also in dealing with the collected excrement in bulk for commercial purposes (see section on *Charcoal System*). My visit happened at a time when the arrangements under this agreement had not come into full operation, and before an opinion could be formed of the hygienic value of the system. I refrain, therefore, from describing the working of the pail-closets at Oldham, excepting so far as to state that the Company were collecting the pails, systematically, at weekly intervals.

Gaddesden (Little).

Gaddesden (Little), Herts.—Here certain cottages, built in couples, on the estate of Earl Brownlow, have had erected for their use improved privies after the following design. A short distance in rear of each couple of cottages, a block of outhouses has been built, constructed of concrete, and containing for each cottage a garden-tool and coal house, a pigsty, and a privy. The privy is fitted, beneath the seat, with a rectangular iron receptacle on wheels. This receptacle can be readily withdrawn through a door at the side of the privy, and one end of it is made moveable on a horizontal axis, the easier to discharge the contents. But this moveable end admits of leakage of fluid, and to obviate the nuisance from this source as well as to facilitate the thorough cleansing of the flagged space beneath the privy seat, the floor of this space is provided with a drain. In one instance where leakage was considerable, this drain did not appear to be acting, and a very noisome puddle had collected beneath the receptacle. When the receptacle is full, it is drawn out, and its contents, covered with vegetable refuse or earth, stored where convenient, or at once used, in the garden plot attached to each cottage.

The conception of this plan of excrement disposal is good, but it fails in certain details. The moveable end of the receptacle is objectionable as leading to nuisance, and the drain beneath the privy seat, while serving the purpose of cleansing the space there, is to be condemned as an outlet for urine and fluid fæces. No sufficient care seemed to be taken to cover the deposited excrement with ashes and dry house refuse, needless stink thus arising ; the collected material, moreover, being in

a state not well fitted for deposit in the garden. The cottages obtain their water supply from waterworks, and there is apparently no danger to this supply even from a careless use of excrement in cultivating the garden.

Paisley.

Paisley.—(*Colquhoun's Closets.*)—At Paisley, in certain manufactories, a peculiar kind of closet, invented by a Mr. John Colquhoun, has been for some time in use. This closet aims at dryness of the contents and continuous removal of any effluvium which may arise from them. The receptacle consists of a moveable pan, with aperture at the bottom communicating with a drain. The bottom of the pan is packed with furnace ashes, gravel, or coarse peat through which the urine is presumed to filter into the drain, and thence flow to a tank arranged for its reception. The solid excrement remaining in the receptacle should, by reason of its dryness prove little offensive, and any odour which might arise from it ought to pass away through a flue carried from the space beneath the closet seat and about the receptacle to a convenient chimney, kitchen or furnace, as the case may be. I examined the operation of these closets in the Anchor Thread works (Messrs. Clark & Co.), where several have been in use two years and a half. Personal examination showed sloppy receptacles, indicating obstruction of the filtering material; and the stink from these receptacles proved that the effluvium shafts exercised little or no effect at the time, although the furnace flue to which they were attached must have been in free action. Information given to me by one of the members of the firm, and by the overseer responsible for the supervision of the closets was to the effect, that at the best there was more smell from the closets than was desirable, and that waterclosets would be substituted for them but for a difficulty in disposing of the sewage. The firm were about to adopt experimentally a charcoal closet in one part of the works, and a new part of the manufactory had been fitted with waterclosets.

Excrement Disposal by Water-Carriage.

Excrement Disposal as to certain kinds of Water-Closets.

Liverpool.

Liverpool.—Since Dr. Buchanan and I visited Liverpool in 1869, no change has been made in the measures adopted by the Corporation with respect to excrement disposal which we then described. It is simply necessary for me to reproduce our report of that date, intercalating certain figures where alterations of number have taken place during the past five years; and further to state that the recent inspection has fully confirmed the opinion expressed in 1869 on the efficiency of the trough watercloset.

"This town has particular interest as showing very remarkable recent improvements in the matters with which this inquiry deals. The midden-closet, which was formerly the only sort of privy for the poorer parts of Liverpool, was constructed on the worst possible plan; and in some courts whole rows of houses had their foundations tunnelled by long excrement receptacles. Some progress in lessening the disgusting nuisances from these arrangements was reported to the department by one of us (Dr. Buchanan), in 1864. Besides improved supervision and monthly removal of midden contents, 2,639 privies in particular houses and in some few courts had, in the 11 previous years, been converted

into waterclosets. But it is since 1864, under the greater powers conferred by the Local Sanitary Amendment Act of that year, that chief progress has been made. There are indeed parts of Liverpool reported at the earlier inspection which cannot now be recognised for the close and fœtid places which they then were. Courts of crowded houses have been demolished, and free ventilation between streets and rows of houses has been obtained. Without these improvements much of the very great amendment that is now seen in the arrangements for filth removal would not have been possible.

"In advising measures for improving the excrement removal arrangements hitherto existing in the town, the medical officer of health, Dr. Trench, has consistently kept in view two principles: the one, to deal only with such midden privies as were, for one reason or another, nuisances, or injurious to health; and the other, to remedy such nuisance or injury in a definite way, by the conversion of these privies into waterclosets of a sort approved by the Corporation. He was met at the outset by difficulties arising from the poverty of owners of property, but the Corporation overcame these difficulties by making contributions from the public funds in cases where the conversion of privies was ordered by the health officer.

"In applying his first principle, Dr. Trench had to lay down, as generally as possible, conditions under which an existing midden privy was to be regarded as a nuisance. The following are such conditions, and they constitute so valuable a code for the general guidance of authorities under like circumstances, that we reproduce them from Dr. Trench's notes of evidence given before the Rivers Pollution Commission. It will be seen that Dr. Trench regards position of a midden privy as being much more important than its construction, in determining whether or not it may be allowed to remain. [The construction and position of new privies are otherwise regulated.]

"'The Act of 1854 provides that, 'when it shall have been certified 'by the medical officer of health that any privy or cesspool was in a 'condition, state, or situation injurious, dangerous, or prejudicial to the 'health of any inhabitants of the borough,' the owner thereof may be required within a reasonable time 'effectually to abate and remedy 'the same to the satisfaction of the Council.' In giving practical effect to the above powers of the law, it became necessary at once and *in limine* to define the nature of the required remedy, and also, as far as possible, the conditions which would justify the certificate of the medical officer. In November 1863, and on subsequent occasions, he laid down certain rules by which he would be directed in the exercise of his certificates. He proposed to certify against,—

"1stly. Midden-privies inside houses.
"2ndly. Midden-privies emptied through houses.
"3rdly. Midden-privies situated beneath rooms.
"4thly. Tunnel middens of every description.
"5thly. Combined open middens supplying many tenements and placed near to inhabited rooms.
"6thly. Midden-privies of private houses clustered together in a *cul-de-sac*.
"7thly. Midden-privies of private houses in close confined yards or situated beneath windows, or abutting on the walls of houses, or within two feet of the lower windows, or of the door of the house.
"8thly. Midden-privies of courts.

" 9thly. Midden-privies abutting on or opening directly into streets and thoroughfares, and emptied before the doors and windows of houses.

" 10thly. Midden-privies of front houses when emptied through a court.

" 11thly. Midden-privies beneath the footpath of the street and emptied through a grid on the footpath.

" 12thly. Midden-privies of many houses, when collected together as a kind of amphitheatre, as is seen in particular groups of streets.

" The council, in order to secure uniformity of action, and likewise to prevent future mistakes in the application of remedial measures, directed the town clerk to notify to the several owners against whom proceedings should be taken, 'That it appears to the said council of the 'said borough that the only effectual remedy for such privies and 'cesspools is by converting the same into waterclosets.' "

" Since Dr. Trench has been medical officer, and mostly since 1866, he has ordered and obtained the conversion of 14,393 privies into waterclosets, and there are now (1869) in Liverpool 20,000 privies attached to ashpits, and 31,150 waterclosets, 2,150 of which are tank or trough closets. The extent to which contributory payments have been made by the Corporation has been 40,000*l.*, expended in this manner: 3*l.* 10*s.* has been given for every siphon watercloset ordered to be erected, 5*l.* 10*s.* for a single trough watercloset, and 7*l.* 10*s.* for a double trough watercloset. These closets are constructed on a pattern ordered by the Corporation, and approved as to details by the borough surveyor." [1874. During the four years 1870–73, the number of privies converted into waterclosets was 756, of which 3 were " trough-closets," the rest " siphon-closets." The number of middensteads now in Liverpool is 15,249, the number of privies attached to them about 20,000. The number of " troughs " for trough-closets is 3,304, serving for about 6,000 closets, and the number of waterclosets other than trough-closets 43,395 (1872). The population of Liverpool in 1871 was 493,405, the number of houses, 78,403.]

" The midden privy (which, where retained, has its old pit construction, all the tunnel middens being done away with), and the ordinary siphon watercloset of the single house, require no special description. But there is particular interest in the arrangement and working of the trough closets, which are in use by numerous families in the sort of neighbourhoods where in other towns ordinary waterclosets are commonly a failure and a nuisance. Drawings of these trough closets will be found accompanying this report (*Plates* XXXII. and XXXIII.) and they describe the construction better than can be done in words. It remains to say that the position chosen for these new closets has been carefully determined by the circumstances of each place where they have been erected, and that peculiar facilities for their being well placed have been obtained by the time of their erection concurring with that of other improvements. The closets that are common to several families are cleansed in rotation by the people using them, and a register is kept of the order in which this should be done. Inspectors visiting the closets every two or three days see that this duty is performed, and are themselves held responsible for any shortcoming. By a little patience and firmness the inspector succeeds in obtaining the necessary cleansing, even among the most intractable classes, with very little assistance from the law. He will, if necessary, wait and see a closet cleaned out by the proper person. Last year only a dozen or so of people were summoned for neglect in this

respect, and three of the offenders had to be sent to prison. It will be seen from the drawing that in connexion with these closets there is an opening of access to the trough and water supply. This opening is for the scavenger, and the people using the closets have no concern with it. The scavengers are employed by the Corporation, and every day they visit each of the trough closets, unlock the iron door of access, discharge the contents of the trough, flush it out with hose and water, sweep it thoroughly clean and leave it charged with fresh water for the next 24 hours' use. Frost has done no harm to these trough closets, nor yet to the ordinary siphon closet with its service box.

"The ashes and other refuse of such houses and courts as have common closets on the trough principle are now put out on the street and carted away daily by the public scavengers. The throwing of ashes about the courts or into the privies is an offence, and under the efficient inspection that is given is becoming of rare occurrence; but where midden privies exist ashes and refuse are of course thrown into the midden-pit.

"There can be no question of the admirable efficiency of the working of the arrangements above described in semi-public privies, nor of the recognition by the people of the superiority of the new to the old arrangements. Nor can there be any question that these results are due even more to the management of the whole business by the public authority than to the excellence of the constructive arrangements themselves. And not only is complete freedom from nuisance obtained where formerly filth and stink were universal, but Dr. Trench states that in 1868, when an epidemic of enteric fever was prevailing in and about Liverpool 'the only localities that seemed exempt from it were 'the places occupied by the poor in which we had removed all the 'privies and made trough waterclosets.'"

Bristol.

Bristol (1871, population 182,552, inhabited houses 27,536).—The provision for excrement disposal in the poorer class of houses in Bristol is of peculiar interest. A privy has long been in use there which is, in fact, a watercloset flushed by hand. The privy in its present state appears to have grown out of some pre-existing usage of which the history has not been very definitely recorded; but the rules by which the construction of the privy are now regulated date from 1865. This privy is held by the medical officer of health for the borough, Dr. David Davies, to meet very efficiently the needs of the poorer classes of the population as to excrement disposal. It appeared to me desirable, therefore, in view of the adverse experience of this department to waterclosets flushed by hand, and to the numerous instances in which inquiry had been made by the department concerning mischief to health arising from such arrangement, to investigate the conditions under which this mode of excrement disposal worked successfully in Bristol. To this end Dr. Davies and the different inspectors of the city gave me ready assistance, and with their help I was enabled to contrast the working of the system in Bristol with its working in the neighbouring village of Westbury-on-Trym, which has recently come under the charge of Dr. Davies as medical officer of health for the newly formed sanitary district in which it stands, but which had not at the time of my visit been placed under detailed sanitary supervision.

The privy is required to be constructed according to the following rules:—

"The Bristol Local Board of Health will not consider any privy sufficient unless it be constructed in the following manner:—

"The trunk of the privy to be of brick work set in cement, and

rendered on the four inside faces with cement not less than one inch in thickness.

"The eject to be of freestone not larger than 18 inches long by 9 inches wide, and 12 inches deep, having the tongue standing at least 3 inches in the water.

"The drain to be of 9-inch stone-ware pipes properly laid and jointed, and with a fall of not less than 1 inch in 5 feet.

"The privy to be ventilated by means of an opening of not less than 9 inches square, communicating with the external air, and if the privy be situate in a dwelling-house and communication with the external air cannot be otherwise readily obtained, an air-tight trunk or shaft of not less than 9 inches square is to be provided and fixed.

"All the works to be executed as the Board's surveyor shall direct, and to his satisfaction."

A drawing of the arrangement of the privy is given in Plate XXXIV, and it will be observed that the "eject" forms a somewhat capacious dip-trap. The "eject" is now also constructed of stone-ware, and "ejects" of this material are permitted to be used in place of the freestone "eject." The advantages claimed for this kind of privy are its little liability to get out of order from careless use or from violence, and the facility with which foreign matters that may have been cast into it can be removed without damaging the structure.

I examined a considerable number of these privies in the poorer parts of the city, and among the population most liable to misuse them, and found with few exceptions the "ejects" free from accumulated matters and the "trunks" clean and without offence. On the other hand, I examined several privies in Westbury-on-Trym of similar construction, and found some of these blocked and the trunks filled almost to the brim with excrement, and others foul within and most offensive. In fact I found the privies here in the state in which I had been accustomed to find other forms of waterclosets elsewhere in which flushing by hand had been depended upon as a means of cleansing them. The difference in the state of the privies in Westbury-on-Trym and in Bristol indicated corresponding differences in supervision, management, and water supply.

In Westbury-on-Trym, to the time of my visit, the local authority had exercised no systematic supervision or control over the management of the privies, and such supervision and control has only now become possible since the sanitary organization formed under the Public Health Act, 1872; the water supply is scanty, and more or less labour is involved in carriage of the quantity of water to the privy needed for the purpose of flushing it; while the incidental help which might be derived from slop water is not uncommonly diverted from the privy by a drain with gully conveniently placed close to the cottage door. The excuse proffered for the state of the privy seen in worst condition was that "the husband came home too tired from his work at night to "undertake fetching pails of water with which to flush it."

In Bristol, as contrasted with this state of things, the Corporation maintains a constant systematic supervision over the privies, and by its servants undertakes the management and cleansing (even to lime washing the closets) of those situated in the worst districts, while the water supply is abundant and close at hand. Three conditions, indeed, are found necessary to the successful working of the Bristol privy, namely :—

1. Frequent systematic inspection.
2. The sanitary authority being prepared to cleanse, and undertaking the cleansing of the privies where necessary.
3. A plentiful and readily accessible supply of water.

Under these conditions the Bristol privy works well in Bristol, but in judging of its applicability elsewhere another highly important consideration should not be overlooked. The poorer population of Bristol which most needs, and indeed absolutely requires the active interference of the Corporation in its sanitary management, is for the most part housed in small houses which rarely contain more than two families. This gives great facility in dealing with individual houses and families, as regards excrement disposal, general sanitary management, and the control of infectious disease. The problem, in fact, of excrement disposal in Bristol is very different from that which presents itself in Liverpool and Glasgow. The number of families having access to a privy in Bristol obviously exercised a considerable influence upon the state in which it was found as to freedom or not from filth.

Bristol.

Bristol has four inspectors of nuisances to each of whom is attached two men. I accompanied one inspector on part of a round to observe the process of cleansing the privies which it was necessary the Corporation's servants should see to. The men were armed with a species of two-pronged iron rake used for the purpose of clearing blocked ejects, and they carried with them freshly slaked lime to sprinkle the "trunks" with. I observed that while a single bucketful of water sufficed to flush some "ejects," others required several bucketfuls. This inspection and cleansing is carried out at weekly or shorter intervals, according as the known necessity of the case requires. I should add that where the arrangement can be made, the rain-water pipes and yard drains are made to communicate with the ejects so as to secure the flushing action of rainfall and of the house slops.

Birkenhead.

Birkenhead.—I visited Birkenhead for the purpose of ascertaining the results of experience there in the working of *tumbler watercloseets*. Mr. Francis Vacher, the Medical Officer of Health, courteously undertook to prepare a special report on the subject, which I here subjoin. This report is as thorough as suggestive, and it renders unnecessary any observations on my part.

Report on the experience of Birkenhead as to the working of the Tumbler Watercloset System, by Francis Vacher, Medical Officer of Health for the District.

"The tumbler watercloset, which is merely a trough closet flushed automatically by means of a water box which capsizes at regular intervals, was introduced into Birkenhead in October 1864, and since that date 40 have been constructed. In many instances they have replaced offensive middens or privies, in some they were designed with the houses they serve, and in two cases they were erected simply to flush the drains from ordinary hopper waterclosets. To a Mr. Matthews, the owner of a small cottage property in the humbler part of the town, the credit is due of having built the first tumbler closet, the idea having been suggested to him by the town surveyor, who was familiar with the system in use at Leeds. As this is one of the best, if not the best, closet of the kind in Birkenhead, I will briefly describe it. The trough is of brick built in cement and cemented over, round-bottomed with a slight fall, and made to retain 4 inches of water by means of a bar. Beyond the bar is a siphon trap protected by a grid. The trough receives from two seats each in a separate locked closet, and the tumbler is in a locked compartment adjoining. The length of the trough from mouth of tip to trough bar is 8 feet. The tumbler is of cast iron, the

Birkenhead.

trunnions being cast in a piece with the box. The measurements are supplied to me as below :—

Length of tumbler		at top	-	- 3 ft.
Do.	do	at bottom	-	- 1 ft. 10 in.
Width	do	„	-	- 1 ft. $7\frac{3}{8}$ in.
Depth	do	„	-	- 1 ft. $\frac{3}{4}$ in.

Trunnions are $6\frac{1}{4}$ in. from top, and 1 ft. $1\frac{3}{4}$ in. from back.

" The tumbler is set in a stout wooden frame built into brickwork, the trunnions riding in cast-iron grooves capped with cast iron. The water supply is direct by a $\frac{1}{2}$-inch pipe fitted with a tap. The tumbler has never been out of order, and the owner only once had it out, and then for the purpose of removing an india-rubber bed that had been fixed to the back part of the frame, and which was not found to be an improvement. Mr. Matthews' double closet accommodates four cottages, the number of adults and children inhabiting which is now 24. Since it has been in use a man has always been paid to cleanse and take care of it.

" Nearly all the tumblers in the town are similar to this. I am told that at least half were cast from the same pattern. The dimensions of four or five that I took were a trifle less than the measurements given above. In some I noticed the trunnions had been riveted on, and a few were furnished with brass bushes. While, however, nearly all the tumblers put up in Birkenhead are alike in pattern and size, there is no sort of uniformity in the troughs they flush. Of the three next constructed (December 1864), one measures 13 feet, receives from four seats, and accommodates nine houses, lodging together 37 persons ; the second measures 29 feet, receives from eight seats, and accommodates 14 houses, lodging 49 persons ; and the third measures 130 feet, receives from 10 seats, and accommodates 10 houses, now lodging 68 persons. The 13-feet and 29-feet troughs are of brick cemented over, each very shallow at one end and deep at the other, and not rounded off, the bottoms forming two inclined planes. These troughs do not retain water, and there is nothing to prevent articles mischievously or carelessly consigned to them choking the 9-inch pipes they deliver into. It is therefore not surprising that during the last three years the condition of each of these tumbler closets has six times formed the subject of a nuisance removal notice. The 130-feet range referred to is a far more objectionable structure. It is not a trough at all, but a series of round-bottomed brick receptacles (neatly built but not cemented over), connected by means of 9-inch glazed earthenware pipes. On May 12th when I visited this row of closets they had just been cleansed, and the man who had been employed for the purpose drew my attention to a bucket of "foreign bodies" he had removed, among which were several large bits of broken crockery, a brick, a piece of cotton cloth, a scrubbing brush, a quart bottle, and an 8-oz. phial corked and labelled, containing medicine.

" Of the 10 tumblers erected in 1865, four deserve special notice. Two, already alluded to, are remarkable as having never served any further purpose than flushing the drains of eight ordinary waterclosets. One, placed at the end of a row of 12 hut closets in a common yard behind a back street (inasmuch as the tumbler and closets are accessible to anyone), is much misused, and the trough, though a fairly well-made one, frequently becomes obstructed. One designed to carry away the soil delivered through 15 seats, sends each charge of water along a line of 15 brick receptacles, connected by 9-inch pipes, pipes and receptacles measuring 185 feet. The population (taken this May) of the 15 houses thus accommodated was 110 all told. Out of the remaining six of the tumblers put up in 1865, only three tip into properly made water-

retaining cemented troughs; the other three, which serve respectively three, five, and five houses, tipping into three, five, and five receptacles, the three connected with 9-inch, and the five each with 12-inch pipes.

"There appear to have been eight tumbler closets constructed in 1866. Three of these were in connexion with property now in ruins, and about to be cleared away by a railway company; two are fairly made trough closets now in use (the trough of one, however, being twice bent at a right angle); one consists of six receptacles connected by and flowing into 9-inch pipes, one of five receptacles connected by and flowing into 6-inch pipes, and one consists of three large cesspits connected by and flowing into 12-inch pipes.

"This last I am desirous of drawing particular attention to. The extraordinary amount of work its projectors designed that one tumbler should achieve is hardly credible. It was to flush beneath 32 seats, accommodating 37 houses; the distance from mouth of tip to the end seat being 119 feet, and the population of the houses served (taken this May when some few were empty) being 191 adults and children. How one tumbler has accomplished such a task may be imagined. On seven separate occasions since June 1871, the owners of the range have been served with a nuisance removal notice in respect of its condition; the number of times it has been cleansed without the interference of the sanitary authority I of course have no means of telling

"Of the tumbler closets put up in 1867, four have well-built cement-lined troughs, one measuring 73 feet, one 10 feet, and two 13 feet each. The latter pair are, however, not without defects; their tumblers being awkwardly placed, the oil holes in the trunnion caps almost inaccessible, and each of the troughs being L shaped. The only other tumbler range built in this year is unique in design. It consists of an arched brick sewer 60 feet long, into which six seats deliver by means of six roughly made man-holes, and is flushed by two tumblers.

"I find no record of any tumbler constructions in 1869, and only one pair of tumblers credited to 1869. One tumbler closet probably opened about this time, after being many times obstructed, and giving much trouble was last year converted into an ordinary trough closet. The 1869 pair are now in good working order; but when I exposed them a few weeks back (they had been carefully sealed up under two flag-stones, as I take it, to prevent anyone tampering with them), they were tilted and fixed, and the closets in a disgustingly foul state.

"I am not able to give with any certainty of being correct the dates of erection of the remaining nine tumbler closet ranges in the township. One has been put up within the last few months, the others all appear to have been two or three years in use. Five are carefully made troughs varying in length from $7\frac{1}{2}$ to 68 feet; three are pipe-joined brick receptacles measuring severally 93, 93, and 51 feet, and one consists of two short troughs united by 9-inch pipes.

"As regards the water supply of these 40 tumbler closets, 16 only were constructed in connexion with cisterns (the three now in ruins being among those thus favoured), the remainder from first to last deriving their supply direct from the mains. Two are served by 1-inch pipes, seven or eight by $\frac{3}{4}$ or $\frac{5}{8}$ inches, and the rest by $\frac{1}{2}$-inch pipes. I mention this as it is a particular that should not be omitted in a statement of this kind; but practically the size of the supply-pipe is not very important, as I found by experiment a $\frac{1}{2}$-inch supply from the main will deliver 18 gallons in from four to seven minutes. Whether the supply is direct or by cistern is of course of paramount importance, as in the former case the tumblers are necessarily idle when the water is "off," in Birkenhead two days a week.

"I have said that nearly all our tumblers are similar in size and pattern, with one exception (that in the girls' yard of the Industrial Schools, which measures 27 inches at the top by 16 inches at the bottom, 10 inches deep, and 13 inches across, and which falls at eight gallons); they are all nominally 21-gallon tumblers, but out of nine whose capacities I tested, only two required 21-gallon charges to capsize them, one capsizing at 20 gallons, three at 18 gallons, one at 17 gallons, and two at 15 gallons.

"Some, when I inspected them, were tipping every 20 minutes, some about hourly, and some apparently only every five or six hours, or less frequently. There is evidently no rule whether a tumbler is found capsizing three times an hour or three times a day, the frequency as often as not simply depending on the person who has last adjusted the tap serving it. When this kindly office has just been performed by a neighbouring house tenant, the tumbler is discovered to be working briskly, when by a waterman the reverse of briskly. For instance, on my directing attention to the mere trickling supplied to one tumbler, I was told by an occupant of the house behind which it was situated that "a man was at it the other day, and he thought it went too fast," and on my telling another house tenant what supply I considered the tumbler on his premises should have, I was answered, "The waterman comes round and he puts the tap slow."

"One tumbler I noticed very inadequately supplied with water had the $\frac{5}{8}$ lead pipe delivering into it neatly flattened, so that it could do no more than dribble. Of course I cannot say the waterman did this, but it had without doubt been done designedly; yet the tenant in whose yard the tumbler receptacle stands assures me it was not done by him, and I am quite certain it was not the work of any servant of the sanitary authority.

"The tumblers in connexion with schools (except those at the Industrial Schools) are not kept working night and day, but merely during school hours, or as occasional flushing boxes. Thus the master at St. John's schools informed me the tumbler was only used at dinner time, and then made to fall three or four times; he attended to this himself to prevent waste, he naïvely added, as there was a meter against him. The man who had charge of the tumbler at Our Lady Schools was, however, even more niggardly in the matter of water; he flushed with two tumblerfuls every evening, and this was all the water he used except on Saturdays, when he thoroughly cleansed tumbler and trough. The master of St. Lawrence's Schools told me he "flushed once a day, or less frequently," but here the rain water helps the master occasionally, the spouting from the roof of this building being directed on to the tumbler.

"As regards the situations of our tumblers, these are not all well chosen. Some are underground and difficult of access; some so close to inhabited rooms that they must prove a source of annoyance, and one is uncomfortably near a seat. Then some instead of being set to face their troughs are at right angles to them, the result being that the force with which each charge of water is thrown is lost.

"Most of the tumblers are very properly housed in locked receptacles, but the locks on some are broken or out of order. Even a good padlock, however, will not always prevent an officious waterman from meddling. Thus, on my asking one of the tenants in Back Myrtle Street if she would obtain for me the tumbler door key, I was brought a poker for wrenching out the staple, at the same time being told, "This is what the waterman uses."

"In a period of nearly 10 years we have only put up 40 tumblers, and

only 12 since 1867. Of the 36 now in use, seven but serve as occasional flushing boxes, two merely assist in cleansing ordinary watercloset drains, and five (that in the park and those in the Industrial Schools and market vaults) are in places where closets of any kind could readily be kept in order. Thus an answer to the important question whether or not tumbler closets are adapted to the wants of the poor must rest, so far as the experience of Birkenhead goes, upon the evidence furnished by no more than 22 such closets. As these all, with a single exception, not unfrequently get out of gear, or become obstructed and cause nuisances, I cannot resist the conclusion that tumbler closets are not suitable at all events for the class of tenants for whom they have been provided in Birkenhead. The foregoing facts not only show the very limited extent of the tumbler experiment in this town, but also the still more limited success it has met with.

"Of course it may be said that the people referred to are peculiarly dirty in their habits. I do not think so; they are ordinary cottage property occupants, skilled and unskilled working men and their families, who pay rents averaging from 4*s.* to 8*s.* 6*d.* per week. But even if they were uncleanly above their fellows in other towns, do not the advocates of the tumbler-closet system contend that it is specially fitted for those who cannot be got to keep clean any form of pan watercloset? With more truth it may be urged that our tumbler ranges have never received the care and attention which is necessary to maintain them in thorough order; but if tumblers are to make the same demands on the time of the township's sanitary labourers as common trough closets it is difficult to understand wherein lies their special advantage.

"No doubt the failure (I am constrained to call it a failure) of the tumbler-closet system here is chiefly due to our ranges having been for the most part ill-planned, too long, and required to serve too many persons. The 22 now in use in connexion with cottage property have an aggregate length of 1,192 feet, receive from 152 seats, and accommodate 191 houses inhabited by 946 persons; thus the mean length per range is 54 feet; the average number of seats each range receives from, 6·9; the average number of houses served per range being 8·6, and the average number of persons 43. The folly of building ranges such as the following, it cannot be necessary to insist upon.

——	Length of Trough or Pipes.	No. of Seats.	No. of Houses accommodated.	No. of Persons accommodated.	
				Adults.	Children.
Oliver Place -	130 feet	10	10	30	38
Eldon Place -	185 „	15	15	57	53
Orderly Place -	119 „	32	37	86	105

"Of the 22 ranges only 6 are in my opinion fairly well constructed, and but one of these is supplied with a cistern.

"As regards the practice in some of our day schools of flushing their closets with a few tumblerfuls at noon, or after school hours, I have nothing to say against this as I have seen troughs thus kept very clean, especially those that get a brushing once a week; but such closets have no pretensions to be classed as genuine tumbler closets.

"The tumbler-closet system appears to me to be so perfect in theory, that I regret I am unable to give a more satisfactory report of my experience of it, and I am still in hopes other towns may be more successful with it than Birkenhead has been.

App. No. 7.

On Excrement Nuisances, by Mr. J. Netten Radcliffe.

Birkenhead.

"That the removal of excremental matter from districts occupied wholly by the working classes may yet be efficiently accomplished by means of tumbler closets I cannot doubt, provided only the closets be properly constructed and placed under careful supervision.

"In conclusion I take the liberty of submitting the following suggestions regarding the structure and management of tumbler closets :—

"I. *The tumbler*, of iron, cast in one piece, and to hold a charge of not less than 18 gallons, should be swung in a strong wooden frame set in brickwork, the trunnion caps being furnished with oil holes and pegs, the whole being in a locked compartment accessible only to the sanitary authority's accredited servant.

"II. *The channel* to be flushed should be a brickwork, cement-lined, open, straight trough, round bottomed, with slight incline, and made to retain water, at least 1 inch, at its shallow end. It should terminate in a syphon-trap protected by a grid, and should not measure more than 25 feet, or receive from more than 5 seats.

"III. *The seats* should be of wood, not painted, each in a separate locked compartment, each exclusively for the use of the occupiers of one house, and accessible only to the occupiers of one house and the sanitary authority's accredited servant.

"IV. *The water supply* should be by cistern, the capacity of each cistern not being less than 1,000 gallons (except in districts where the mains are always charged), and the service pipe should be fitted with a ferrule of a size to enable it to deliver not less than 18 gallons every 40 minutes.

"V. *Inspection* should be undertaken by the sanitary authority, and should be systematic, thorough, and frequent ; every tumbler, channel, seat, and cistern in a district being examined by a servant of the sanitary authority at least once a week."

Worksop.

Worksop (1871, population 10,409; inhabited houses 2,074).—I had reason to believe that I could study with advantage in operation at Worksop waterclosets flushed by hand with slops and waste water, and I visited that town for the purpose. I found, however, that the total number of waterclosets in the town did not exceed 90, and of these from 18 to 20 only were without cisterns. Other provision for excrement disposal consisted of the common midden closet. The surveyor and inspector of nuisances entertained a strong objection to the waterclosets without proper water supply, from the liability to blocking of the drains connected with them. I inspected 11 of these closets with the following results : in five the pans were very filthy ; in five others the pans were more or less smeared with excrement ; and in one only was the pan in a proper state of cleanliness.

The Dry-Earth System.

Dry-Earth System.

The dry-earth system of excrement-disposal, designed and perfected by the Rev. Henry Moule, M.A., vicar of Fordington, Dorset, is best described in the words of Dr. Buchanan, given in his report of an official inquiry concerning the subject made in 1869. He writes as follows :—

"The dry-earth system consists in the application, with the greatest procurable detail, of dry earth to fresh human excrement, and in the subsequent removal and use of the mixture for agricultural purposes. In so far as detailed application is not made, or as the earth is not dry, or the excrement

not fresh, or the mixture otherwise dealt with, the dry-earth system is departed from.

" If about a pound and a half of suitable earth, carefully dried, be thrown over a dejection, all smell from it is forthwith removed, and if the same quantity be mixed with half a pint of urine the latter is absorbed. The mixture of earth with stool and urine is not only inoffensive when fresh, but remains so after keeping for two or three months, or longer.

" The process which goes on in the mixture is obviously one of disintegration and of some combination between the earth and the organic matter, as is evidenced by the disappearance of stools and even of paper among the other constituents of the compost. But the absence of fœtor from the mixture of earth with stool or urine, even with prolonged keeping, shows that decomposition in the ordinary sense does not take place.

" The Rev. H. Moule, to whose observations the practical use of these facts is due, regards the process which takes place in the mixture as consisting in a change of the organic substances of excrement into the state in which organic matter naturally exists in fertile soil, in such a way that the animal refuse becomes proximately available for the support of the plant, without undergoing ultimate reduction into simple salts and gases.

" In order that the described result shall be efficiently brought about, the quantity and quality of the earth have to be considered. With any quantity materially less than a pound and a half to the average dejection, (unless some artificial means, not generally applicable, of mixing are had recourse to,) a tendency to wetness remains, and more or less fœtor results. If much more earth is used the proportionate agricultural value of the product is lessened. The quality of earth, as affecting its power of producing an inoffensive compost with excrement, is of at least equal importance with its quantity. Sand and gravel have almost no power in this respect. Chalk has very little. Clay stands very high in rank. Properly dried it falls readily into a convenient powder which has great power of absorption and of preventing offensive change. High in rank also is surface earth, that which is loamy being preferable to any of peaty character. One of the best of all earths is the brick earth of the drift. Earths which already contain some quantity of organic matter are very suitable. Some one of these better sorts of earth may be readily procured in most parts of England.

" The mixture of excrement and earth appears to become more intimate after a little time has elapsed; for whereas the mixture when fresh will, if exposed to heat or wet, enter into ordinary decomposition and become fœtid, it may (if a proper proportion of good earth have been used), after remaining a month or so (during which time it gives off no offensive gases), be exposed to wet and to any moderate degree of heat without the production of any smell.

" I have next to mention a circumstance, of the truth of which I have complete evidence, both from the statements of those who have used the system and also from my own observation, but which was at first unexpected and surprising to me. It is that the mixture of excrement with earth, after being kept awhile and then dried, has again the power which the original earth possessed of absorbing and making inoffensive any stools and urine to which it is applied. This power is so marked that it has repeatedly been alleged to me that the earth (especially if clay) acts better a second time than the first, and I can answer from my own observation that earth used three and four times over, with drying at the proper stages, will render excrement quite inoffensive. The limits of this power do not appear to have been reached, but for experiment's sake the earth has been employed a dozen and more times over, when it must have come to have more than half its bulk of excrement, with the same result on the dejections as at first."

When Dr. Buchanan made his inquiry in 1869, certain debatable and some doubtful questions occupied much of his attention. So far as the present inquiry is concerned, but one of these questions needs consideration, namely, the extent of applicability of the system to communities.

Of the value of dry-earth as a means of abating excrement-nuisance no question, I presume, now exists; and its application in detail to

Dry-Earth System.

this purpose has been facilitated to the utmost by the ingenious mechanical arrangements devised and patented by Mr. Moule and Mr. Girdlestone (the engineer of Moule's Earth-Closet Company). These arrangements, which provide for proper charges of dry-earth being thrown upon the deposited excrement, admit of ready adoption of the system in houses, schools, and other institutions.

Since Dr. Buchanan's inquiry the system, in its integrity, has been adopted in many mansions and on numerous estates, as well as in not a few public and private institutions. The wider experience of its use under these circumstances does not differ in result from that which has been already recorded by Dr. Buchanan, and it would serve no useful purpose to enter into a detailed examination here of the different instances which came under observation during this inquiry. So far as my observation went, wherever the system had been intelligently applied and carried out, and due supervision over its working had been maintained, there its success in the abatement of nuisance from and the disposal of excrement had been assured. Where the system had been adopted without due regard to the amount and kind of labour at disposal and the amount of supervision which could be secured, there it had failed, as any other system would have failed, under like circumstances. Other important sources of failure, so-called, cannot rightly be accredited to the system. The chief of these were imperfect preparation of the earth, and mixing with it, or substituting for it, dry coal ash. In several places I found that the so-called dry-earth system was a dry-ash system, and that the defects arising from the little else than mechanical action of dry coal-ash as a deodoriser were wrongfully spoken of as belonging to the dry-earth system.

The most interesting applications of the system which I observed during the inquiry were among certain mining and colliery villages in Yorkshire and Durham, and at the Industrious Aid Society's cottages and farm at Hereford.

At Skiningrove, a village on the sea coast, at the foot of the Cleveland Hills, and adjoining the Lofthouse iron-ore mines, I saw 66 earth-closets in operation. The mines are the property of Messrs. Pease, of Darlington, and the earth-closets had been introduced at the suggestion of Mr. France, the manager. The closets, of which the mechanism had been constructed by Moule's Earth-Closet Company, were in excellent order, and the earth supplied to them, a clayey soil obtained from the foundation of buildings, had been carefully dried in a proper kiln erected for the purpose. A few of the closets had lever-seats, in others the earth was cast from the hopper upon the excrement by a handle acting upon a simply arranged "chucker." A man was detailed to prepare the earth and keep the hoppers supplied; and an arrangement had been made with neighbouring farmers to remove the contents of the closets once in every three weeks. No difficulty had been experienced in making this arrangement; indeed, the farmers, it was told me, very gladly undertook the task for the value of the manure, and further, they had engaged to supply earth for the use of the closets when that obtained from new buildings failed. An inspection of the closets showed that the users had not habituated themselves to putting the mechanism in action after use, and that in consequence in some, although the hoppers were full of earth, the excrement was uncovered. This, however, appeared to have arisen rather from an oversight in the management than from any indisposition on the part of the cottagers to use the closets properly. It had been too readily assumed that the population for whom the closets were designed would take to their use without some instructional supervision. The advantages of the closet, as com-

pared with the old-fashioned midden-closet were, however, so obvious, even in the state that I saw them, that Mr. France was about to introduce 200 in a new mining village then in process of being built on the hills above Skiningrove.

At the Adelaide collieries, Shildon (Bishop Auckland), also the property of Messrs. Pease, a row of cottages lately erected has been furnished with earth-closets. These closets, placed in the yards in rear of the cottages, are furnished with apparatus similar to that adopted at Skiningrove, as described in the foregoing section, and also prepared by Moule's Earth-Closet Company. The proprietors undertake the charge of supplying the closets with earth and removing their contents, the hoppers being filled weekly and the closets cleansed every three weeks, the contents being used upon a farm adjoining the colliery. The earth, a surface soil, is not specially dried, but simply placed for a time, and occasionally turned over, in a shed attached to a gas-house. The occupants of the cottages belong to the better class of colliers, the whole of their surroundings being characterised by comfort and orderliness. In almost every instance the closet was found to be in proper use, and the excrement covered with earth. A few had a little wet in them, but of these one or two only had any offensiveness, and in two, the contents of the hopper having become exhausted by an oversight of the filler, the excrement had been covered in one case by sand, in the other by ashes. The several cottagers to whom I spoke on the subject were, with one exception, enthusiastic in their preference for the earth-closet as compared with the old midden-closet, and more than one spoke of its greater decency, and of the influence of this upon the habits of growing children. In this respect, the instances I have just mentioned of the covering up of the excrement with ashes and sand when the earth failed, are instructive. One woman, however, expressed a decided preference for the old privy stink as compared with the new privy (earth-closet) stink. More specifically she complained that, unless she kept the closet door constantly open, there was at times a most disagreeable odour in the closet. The closet was one of the wet ones, and her complaint directed attention to the fact that no sufficient provision had been made for the ventilation of the closets.

The Hereford Society for Aiding the Industrious has 11 model cottages and a model farm on the outskirts of the city. The dry-earth system is in use here not only for the inhabitants of the cottages, but also for the piggeries and the fowl-pens; and the farm (9 acres) and plots of garden attached to each cottage (one-sixth of an acre) are wholly cultivated with the manure from the dry-earth closets, pig-styes, and fowl-pens. Some slight amount of sub-irrigation from house slops in the garden plots may be put out of consideration as aiding cultivation, from the limited extent to which the liquid is distributed in the irrigating drains. Each cottage has its arrangement for drying earth, but the rule of collection and preparation would appear to be to gather earth (a fine surface soil) in dry weather, and store for use, without artificial drying, sifting the fine earth from the coarse before charging the closet hoppers. The receptacles of the closets are built of brick, and cemented within. They measure 2 feet 6 inches by 4 feet, and 3 feet 6 inches in depth. The contents are removed twice or thrice yearly by the cottagers, according to the fulness of receptacle, or to garden requirements, as the case may be. I noticed here, as also at Halton, that several receptacles had within them a large number of small flies. Frequent insufficient covering of the excrement, from the use of the closet by children, might have something to do with this phenomenon.

The dry-earth is passed three times through the closets which serve for this purpose to form manure for the farm; but in the piggeries and fowl-pens the dry-earth is used once only. Each cottage has its pigstye and large fowl-pen, and on the farm a great range of pigstyes and fowl-pens has been built, with mushroom- and rhubarb-forcing cellars beneath, of admirable construction and design. A layer of dry-earth, of from two to three inches in thickness, is spread at the bottom of each fowl house; this is raked over every morning, the upper surface being removed, and the earth is replaced as often as necessary. The floor of the outer portion of the pigstye is laid with a slight fall to a depression or gutter. Into this depression the urine flows, and the filth is swept several times a day, all being covered up with dry-earth. The cottagers are encouraged to follow the same practice with their pigs and fowls.

The earth-closets I examined were well managed, and the dry-earth appeared to be equally effectual in obviating nuisance from the excremental matters of pigs and fowls as of human beings.

I may note here that Mr. James, of Halton, pointed out to me a very useful application of the dry-earth system to cats. It would appear that cats take readily to an open box or other receptacle charged with dry-earth, and that this affords an excellent means of obviating the nuisance they are apt to create.

The statements made to me by Mr. Walters, the manager of the farm, of the great agricultural value of the earth-closet manure, accorded with statements I had already heard to the same effect from the Rev. Mr. Moule, Mr. James, of Halton, and Capt. Armytage, of the West Riding prison. Mr. Walters had a ready sale for the earth-closet manure, in small quantities, for garden purposes, at the rate of 6*s.* per cwt., and sales to the extent of between two and three tons had been effected at this price during the preceding 12 months. What part the earth-closet manure and the mode of cultivation respectively played in the agricultural successes Mr. Walters described to me, I am unable to judge, but it was impossible not to be struck by the detailed care given by him to his different farming and garden operations.

With the exception of the Corporation of Edinburgh, which has recently introduced public earth-closets into that city, as described in a previous section (p. 157), the Corporation of Lancaster is still, as at the time of Dr. Buchanan's inquiry, the sole sanitary authority (so far as transpired during this inquiry), which has adopted the dry-earth system; and in this case the adoption is only partial. When Dr. Buchanan visited Lancaster, 90 earth latrines, serving for 200 privies and 450 houses, were under the control of the Corporation. The number of earth latrines is now 120, including the latrines serving for a large school, and the houses thus provided for number about 500. The dry-earth system, although continued within these limits by the Corporation, is not now being extended. For new houses waterclosets are adopted The latrines are mainly old middensteads roofed in. The dry earth is stored up in one part and replenished from time to time. Once a day a servant of the Corporation visits the latrine and shovels over the excrement and urine deposited since his last visit a sufficient quantity of dry earth. The quantity of dry earth used weekly for the latrines amounts to 22 loads, each load weighing from 23 to 24 cwts. The earth is obtained from the foundations of new buildings, and about 18 months' stock is in store. Street sweepings are occasionally substituted for or used with it. At the time of my recent visit, street sweepings were alone in use, on account of the apparatus for drying earth being temporarily out of order. The contents are removed every six or seven weeks, and carted to the

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Corporation yard, where they are mixed up with blood offal from the shambles and street sweepings, and stacked in an open shed until required by the farmers. It was reported in 1869 that subsequent processes of preparation were adopted of a kind that formed no part of the dry-earth system proper ; but in 1869 these processes were at least carried out at such a distance from the town as not to create a nuisance. Now, in the Corporation yard, they are effected in close and very improper proximity to houses. At the time of my visit a great pile of the manure, giving off a pungent offensive odour, was awaiting sale. In 1869 the manure sold for from 7*s.* 6*d.* to 10*s.* the ton. The selling price is now 3*s.* a ton, and this fact, as well as the consideration that the time will probably come before long when earth must be bought for the latrines, instead of as now being simply obtained for the cost of carting, has no doubt largely influenced the judgment of the Corporation in ceasing to extend the dry-earth system. The sanitary gain from the latrines, measured by diminution of excrement nuisance and as compared with the old middenstead, is very considerable.

The dry-earth system, as practised at Lancaster, was introduced into that city, with the approval of the Corporation, by a gentleman since deceased; the Corporation subsequently adopting and extending very slightly, the system as first put into operation. The dry-earth system here is not a fair representation of that system as originally designed and intended to be carried out ; and the history of its introduction and the method of management do not furnish such information as is to be desired for sanitary authorities regarding the adaptability of the system to the needs of a community in relation to excrement disposal. It may be taken that the system fully meets the requirements in this respect of certain kinds of institutions and of certain communities living on estates, or in connexion with mines or manufactories, under private management. But the question of adaptation of the system to a mixed community, for which the local authority must devise and carry out provisions for its sanitary welfare, has yet to be solved practically. It must not be too hastily assumed that the very fact of no local authority having adopted, of its own motion, the dry-earth system during the several years it has been before the public, is decisive against its adaptability to public requirements as to excrement disposal. The truth is, that only now does such a local sanitary organisation exist as would admit of its application in those villages and towns where presumably the system is best fitted for operation. Before the Public Health Act, 1872, the sanitary organisation of rural districts and of many small towns was too incomplete to give any reasonable hope of the efficient working of a system, whether the dry-earth or any other, which required careful and systematic supervision and management. Since the passing of that Act, an organisation fitted to these ends has either been established, or is in progress of establishment, in every part of the kingdom. It is, perhaps, even more necessary now than when Dr. Buchanan reported, that sanitary authorities, in examining the sanitary requirements of their districts, should have under their consideration the dry-earth system among other systems of dealing with excrement nuisances.

I have already mentioned the great value assigned to the earth-closet manure by certain gentlemen who are well acquainted with its practical use. This opinion, held also when Dr. Buchanan made his inquiry, has undergone no change, but has been confirmed by the five years additional experience since that inquiry took place. On the other hand Drs. Gilbert and Voelcker, studying the question chemically, have shown that the earth-closet manure after it has been charged twice, or even

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thrice, with excrement is no richer than good garden mould.* Mr. Walters, as I have stated, gets 6*l.* a ton for the manure retailed in small quantities, and I may add, that he believes this sum fairly represents the value of the material. Dr. Voelcker estimates the value of the compost after it has been charged five times with excrement at 7*s.* 6*d.* per ton. I cannot pretend to reconcile the differences; I merely state the facts. But it may be observed that the chemical estimate of the value of earth-closet manure, does not disprove the sanitary value of the dry-earth system, but, so far as it may be the true index of value, only tends to shew that its economical adaptation must be limited to cottages and small towns, where the cost of providing and drying the earth and distribution of the manure will be of the smallest. On this question, the Committee on the Treatment and Utilization of Sewage appointed by the British Association for the Advancement of Science has said, as to houses and villages (again looking at the value as a matter to be estimated by chemical analysis), that the dry-earth system "might be even "economical where the earth for preparation and absorption and the land "for utilization, are in close proximity."†

Without desiring to under-rate the commercial aspects of the question, it appears to me that it is the economical aspect in the sense of obtaining an unquestioned good at the least cost which has place here. If the value of a method of excrement-disposal is to be estimated by its profitableness as a pecuniary investment, rather than by its hygienic success, all measures at present in use in this country would have to be condemned. From the former stand-point the best, perhaps, that can yet

* I give the following analysis, one of several showing similar results, by Dr. Voelcker :—

Composition of Earth and of three Samples of Earth-closet Manure produced at West Riding Prison, Wakefield, in dry state (dried at 212° Fah.).

	No. 1. Earth for use in Closets.	No. 2. Earth once used in Closets.	No. 3. Earth twice used in Closets.	No. 4. Earth thrice used in Closets.
Organic matter and water of combination	9·88	9·79	11·53	12·22
Oxide of iron and alumina	12·95	16·15	14·11	12·48
Phosphoric acid	·18	·25	·44	·51
Carbonate of lime	2·21	2·25	2·13	2·14
Magnesia	1·44	2·63	·77	·90
Alkalies and loss in analysis	1·35		·72	·74
Insoluble siliceous matter (clay and sand)	71·99	68·93	70·30	71·01
	100·00	100·00	100·00	100·00
Containing nitrogen	·31	·37	·42	·51
Equal to ammonia	·37	·45	·51	·62

"On the Composition and Agricultural Value of Earth-closet Manure." "Journal of the Royal Agricultural Society," No. 15, p. 185 (1872).

† Report, 1872, p. 188. Drs. Gilbert and Voelcker were both members of this Committee.

be said of the completest of these is, that it is the least costly. From the sanitary stand-point it is unfortunate, although quite explicable, that the promoters of the dry-earth system should have rested its advantages so largely upon its presumed results for agricultural purposes. Their experience must, however, be taken as showing that there are certain conditions of use of earth-closet manure which justify their enconiums of it as a manure; and there is no sufficient reason to believe that a multiplication of like experience would lead to different results. But adopting the chemical estimate of the value of earth-closet manure, it still leaves the question in this not particularly unfavourable position, namely, that the dry-earth system is perhaps the only method of excrement-disposal at present practised in this kingdom, which wholly or almost wholly would probably cover the cost of working, if it were judiciously put in operation within suitable districts.

Thus regarded, Dr. Buchanan's estimate of the conditions and cost of application of the system to a community of 1,000 persons is as instructive now as when written, and I reproduce it with a few modifications and with the omission of that portion which relates to the estimated value of the manure.

"I now find myself in a position to state, with some approach to accuracy, the way in which the earth system may be worked, as well as its approximate cost and produce. I need not here consider the case of public institutions or of very small villages, as the instances quoted sufficiently illustrate the operation of the system there. But for my present purpose I begin with the case of a village population of 1,000 persons already provided with the ordinary arrangement of outside privies and cesspools. People making use of closets as receptacles for all stools and urine from every inhabitant, may be taken to use them on an average three times a day each,* and to require for each use 1½ lb. of dry earth. This gives 4,500 lbs., or two tons, as the daily quantity of earth required for the population. The amount that would accumulate in the closet pits, and which would need to be removed about four times a year, would be larger than this by the bulk of the stools and of such portion of urine as did not evaporate; but without reckoning increase on this score, the quantity of manure produced may be reckoned at the same quantity of two tons a week.

"I assume that, after owners of property have paid the original cost of providing earth-closets according to the scheme of the local authority, all supply and maintenance of them should be the function of that authority. The cost to owners would vary (1) according to the adaptability of the existing arrangements, and (2) according to the character of the earth arrangements to be required. The latter may either consist, as at Lancaster, in a single daily application of earth to the closets, or much preferably, as at Halton, in an arrangement for the mechanical delivery of earth after each use of the closet. In this latter case an average outlay for structural alterations and machinery of some 3*l.* or 4*l.* might be required in respect of each closet.

Expenses in village.

"The expenses which, for the efficient management of the earth-closets of such a population, would have to be borne by the local authority, consist first in an original expenditure of some 250*l.*, and in a continuous weekly expenditure of about 4*l.* 15*s.*, as follows:—

Agricultural value.

Capital:—	£	s.	d.
Drying sheds and furnace	150	0	0
Cart and horse	50	0	0
Other outlay	50	0	0
Two men's wages, at 16*s.*	1	12	0
One boy's wages	0	10	0
Horse keep	0	18	0
Firing (at 1*s.* 6*d.* for each ton of earth)	1	1	0
Purchase of earth (at 1*s.* a load)	0	14	0

* "Closets used in the ordinary way, for stools and part of urine only, would not be so often visited. Less than two visits daily by the average person would be estimated for such use."

The two men and boy could perfectly well manage the collection of earth, its drying and distribution, and the removal of the product, not only for our village of 1,000 inhabitants, but for a place, if lying compactly, of a hundred or two more.

"The annual cost to the authorities then would be (52 × 4*l.* 15*s.*) 247*l.*, and with the addition of 13*l.* as interest on capital, 260*l.* The removal of ashes might very well come within this amount, for if the labour of collecting were somewhat increased, there would be a saving in fuel by the gain of the cinders, and also a gain (to which little importance, however, attaches) of dry dust that might, in some circumstances, be used with the earth to the closets.

"The quantity of manure got from the earth-closets of the village would each year amount to 730 tons, or, from the consideration before advanced, more. The cost of production of this will have been 7*s.* a ton. . . . .

"This then is the way in which it appears that the earth system may best be worked in the village or small town. But it is susceptible of some modifications. For instance, if it be desired to irrigate partially with the refuse of the inhabitants, a part of the urine may be allowed to flow into sewers, or it may be wished to use some of the liquid refuse direct on cottage gardens; and, of course, in such cases less manure (at less cost) will be got from earth closets. And there appears no reason why an earth system should not be used in certain parts of a town, and a watercloset system in other parts. Especially when one remembers what a delicate machine the watercloset is, the use of the earth system may prove to be particularly useful for the poorer parts.

"The extension of this scheme beyond the village of 1,000 people to larger towns appears to be essentially a question of multiplication, with these differences: on the one hand, an organization on a large scale can commonly be had more cheaply than one on a small scale, and in this way and by its compactness the town has the advantage over the village; on the other hand, labour is dearer in towns, and towns often have their closets so arranged that it is difficult without much cost to adapt them to the earth system, and thus the village has advantage over the town. Further, in towns, which must necessarily be supplied with sewers for the purpose of drying the soil, and for removing rainfall and house slops, the question arises whether it may not be more advantageous to throw all foul matters together into these sewers. I do not propose to discuss the relative merits of a watercloset system and of an earth-closet system; this must depend upon a variety of considerations proper to each particular place. In a locality where sewage can be cheaply delivered upon suitably situated land, where the amount of sewage dilution is such as fits it for the particular crops that are marketable, where the irrigable land is of such extent and quality as effectually to remove the manurial constituents of sewage, and to allow of the effluent water passing off in sufficient purity; in short where sewage irrigation can be effected with profit to the people and safety to the health of themselves and their neighbours, I should anticipate a preference for a system of water carriage for the excrement of the place. But for populations where these conditions may not be attainable, or where experience may show greater profit realizable from solid manure, I should suppose that the earth system would find advocates in preference to the water system; and it is impossible to ignore the fact that many large English towns do not regard the watercloset system as suited to all their particular wants, nor irrigation as being a remedy certainly suitable to their particular sewerage difficulties. I refer, of course, to towns which, although possessed of a system of sewers, nevertheless retain their excrement in middens or cesspools, deliberately avoiding waterclosets as not affording them the certainty of advantage which they need to have before they enter upon expensive new constructions. By the authorities of such towns the earth system will especially deserve consideration as promising them the means of making harmless their retained excrement by a system readily, perhaps, adaptable to their present privy construction, and not involving in its introduction a new kind of difficulty."

The present inquiry has led me to conclusions as to the hygienic

advantages of the dry-earth system similar to those arrived at by Dr. Buchanan in 1869, and I adopt mainly his words in stating them.

(1.) The earth-closet, intelligently managed, furnishes a means of disposing of excrement without nuisance, and apparently without detriment to health.

(2.) In communities, the earth-closet system requires to be managed by the authority of the place, and in limited communities it will probably pay at least the expenses of its management.

(3.) In the poorer class of houses, where supervision of any closet arrangements is indispensable, the adoption of the earth system offers especial advantages.

(4.) The earth system of excrement removal does not supersede the necessity for an independent means of removing slops, rain water, and soil water.

(6.) As compared with the watercloset, the earth-closet has these advantages :—It is cheaper in original cost ; it requires less repair ; it is not injured by frost ; it is not damaged by improper substances being thrown down it, and it very greatly reduces the quantity of water required by each household.

Note.—In the course of the present inquiry, an instance came to my knowledge of disease occurring in a place where earth closets were used, namely, certain states of ill health and an outbreak of enteric fever in the West Riding gaol, Wakefield, which the medical officer, Dr. Wood, believed to have been connected to some extent with the use of earth-closets there.

The *West Riding Prison*, Wakefield, has for eight years had numerous earth-closets in operation within it. The provision for the excrement-disposal of the prisoners confined there consists now of earth-closets and waterclosets in equal proportions, the number of each form of closet being about 800. The arrangements for drying the earth, preparing it for the closets, and for subsequently storing the contents of the used closets, are the most complete I have seen in any institution. The dry earth, before being distributed to the closets, is sifted through a sieve having a $\frac{1}{4}$-inch mesh. Formerly, closets with lever-action seats were used, but now the simpler arrangement of a scoop for covering the deposited excrement with the dried earth is in use throughout the prison. On the male side the prisoners are instructed not to pass their urine into the closets, but to use for the purpose a separate vessel. This urine was not, at the time of my visit, mixed with the compost removed from the closets, but was sold for scouring to blanket manufacturers. The average duration of the confinement of a prisoner in this prison is 53 days ; the maximum duration two years.

In November, 1870, enteric fever appeared in the prison. From a detailed report on the subject, which has been courteously forwarded to me by Dr. Wood, the medical officer, it appears that this malady had been so long unknown in the cells that it was almost a "new disease" within them. Seven cases of the disease took place in November, two in December, five in January, 1871, and three in February, after which month there were no further cases. Eighteen cases occurred altogether, of which 13 happened in the male division of the old prison buildings (the E. prison), four in three of the four wings of the new prison buildings,

wholly devoted to males; (two in B. wing; one in C. wing; and one in A. wing); and one case occurred in December, in the reception cells. The origin of the outbreak was obscure, but it was believed to be connected with the prison itself, all the prisoners first attacked having been several months in confinement. The first case of enteric fever had occurred on the 21st October in the new buldings, the person attacked having entered the prison on the 21st March. The four next cases occurred in rapid succession (one on the 22d November, two on the 24th, and one on the 26th) in the old buildings among prisoners who had been in the prison 2, 4, 7, and 10 months respectively.* The outbreak took place at a time when there had been considerable deterioration of the prisoners' health in certain parts of the prison, believed to have arisen partly from deficiencies in the dietary then in force, partly from defects in the ventilation of certain parts of the prison, and partly from the mode of managing the earth-closets. The contents of the earth-closets at this period were removed from the cells only once a week, and it is stated to me that before the expiration of this time the cell was very commonly pervaded by a faint, unpleasant odour, coming from the mixed earth and excrement, and which no care in covering the excrement with abundant earth entirely obviated. It was believed that the enteric fever, and especially its localisation, was connected with the presence in a notable degree of the several conditions of unwholesomeness mentioned; and that in the older buildings of the prison (the E. prison where 13 of the 18 cases of fever occurred) the state of the water supply, obtained from a surface-well within the precincts, might have contributed to the localization.

A sub-committee of the magistrates investigated the different conditions of unwholesomeness referred to, and in April 1871, as the results of its deliberations, the water supplied to the E prison (and which had been shewn by chemical analysis to be impure) was discontinued, and a supply from a purer source introduced; necessary changes in ventilation and warming of the unwholesome cells were carried out; the effects of the sparer dietary of the early period of imprisonment were more closely watched; and the following changes were directed to be made in the regulation of the earth-closets:—

19th April, 1871.—"That the pans in the earth-closets be emptied and

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* The dates of admission into the prison and into the hospital of the several cases of enteric fever were as follows:

Order of Cases of Enteric Fever.	Dates of Admission.		Order of Cases of Enteric Fever.	Dates of Admission.	
	Prison.	Hospital.		Prison.	Hospital.
1	March 11/70.	Nov. 21/70.	9	Aug. 10/70.	Dec. 11/70.
2	Sept. 17 „	„ 22 „	10	Dec. 16 „	„ 19 „
3	Aug. 24 „	„ 24 „	11	Nov. 23 „	Jan. 12/71.
4	Jan. 6 „	„ 24 „	12	Nov. 26 „	„ 12 „
5	April 4 „	„ 26 „	13	Aug. 10 „	„ 12 „
6	May 24/69	„ 27 „	14	Jan. 2/71.	„ 18 „
7	Oct. 3/70.	„ 28 „	15	Jan. 13 „	„ 22 „
8	June 27 „	Dec. 2 „	16	April 20 „	Feb. 8 „

In addition, two prisoners from Coldbath Fields prison were admitted into hospital Feb. 15th and Feb. 17th respectively, both with enteric fever; the dates of admission of these prisoners into the West Riding prison are not stated.

" cleaned at least three times a week. That the earth be not used more than " once in the closets in the cells. That a scoop be supplied to each cell to be " used by prisoners in case of any defective or insufficient action in the " machinery of the closets. That earth after being used in closets, be not dried " in the present drying house, situate in the A. courtyard of the prison, and " which they recommend be used for drying clean earth only. That printed " instructions for the use of the closets be placed in each cell, and the neglect " of them treated as a breach of prison rules, and that the closets be frequently " inspected by officers of the prison as to their observance."

The enteric fever had ceased before these various changes were made, the last case having been admitted into hospital on the 17th February. Since the alterations the general health of the prisoners has improved; there has been no occurrence of enteric fever, and the working of the dry-earth system appears to give rise to no greater offensiveness in the cells than the watercloset system. During an inspection I made the number of instances of carelessness in the use of the earth-closets and of waterclosets which came under observation was about the same, but the offence seemed to me more obvious from the watercloset than the earth-closet.

This account of the presumed connexion of the outbreak of enteric fever described, with, among other conditions, defective working of the dry-earth system, I have given from the reports of Dr. Wood, written at the time. The progress of the outbreak and the circumstances under which it occurred, do not suggest to me other than an incidental connexion of the unwholesome conditions referred to with the enteric fever. Information is wanting as to the prevalence, at the time of the outbreak, of enteric fever in the town of Wakefield, and especially among houses in the immediate vicinity of the prison, situated above the stratum of ground from which the polluted well derived its water. When I inspected Wakefield in 1869, under instructions from the Privy Council, the people living in those houses deposited their excrement, as the people living there now still deposit it, in old privy-pits sunk into this stratum. Dr. Wood took objection to the management of the earth-closets, at the time of the outbreak, rather than to the dry-earth system. Of the present management of the closets in the prison, he remarks in a letter addressed to me on the subject: " As regards the earth-closets, with the " supervision we now have, I can urge no objection to them pro- " fessionally."

When Dr. Buchanan made his inquiry in 1869 as to the dry-earth system he gave consideration to the great prevalence of diarrhœa in the camp at Wimbledon, during the meeting of volunteers in the exceptionally hot summer of 1868, and which was held by some to have arisen from the use of earth-closets in the camp. It was shown by Dr. Buchanan that this prevalence was not local, but was part of a general prevalence, common to the camp and the whole of the metropolis, and that therefore the assumed connexion with the use of earth-closets could not be sustained. I visited the camp during the present inquiry, and the following table, prepared from figures courteously furnished to me by Staff-surgeon Owen, the principal medical officer, and showing the amount of diarrhœa at each of the Wimbledon meetings from 1868 to 1874, is of interest. The use of earth-closets in the camp has been continued from year to year, and when I inspected them on the eleventh day of the present year's meeting (1874), the working of the closets in

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the volunteer encampments, under the charge of Moule's Earth-closet Company, was admirable * :—

Force.	Wimbledon Camp.													
	1868.		1869.		1870.		1871.		1872.		1873.		1874.	
	Strength.	Diarrhœa.	Strength.	Diarrhœa.	Strength.	Diarrhœa.	Strength.	Diarrhœa.	Strength.	Diarrhœa.	Strength.	Diarrhœa.	Strength.	Diarrhœa.
Army -	548	41	670	0	655	3	400	2	633	1	607	1	643	1
Volunteers -	1,172	173	1,071	33	1,177	21	1,206	7	1,477	10	1,265	7	1,654	1
Police -	232	45	265	8	248	3	256	3	265	3	248	0	248	1
Camp Followers -	207	50	419	18	75	3	441	4	262	7	577	1	464	—
Totals -	2,159	309	2,425	59	2,155	30	2,303	16	2,637	21	2,697	9	3,009	3

III.—The Charcoal System.

Charcoal System.

The use of charcoal for deodorising, and subsequently disposing of excrement, came under observation during the inquiry in connexion with the operations of two commercial companies. One of these companies is the *Universal Charcoal and Sewage Company, Limited*, and the other the *Carbon Fertilizer Company, Limited.*

The Universal Charcoal and Sewage Company has works at Salford, in the Town's Yard, where it manufactures a charcoal from street sweepings. This charcoal, applicable to the various sanitary purposes to which charcoal can be put, is not used in detail in the deodorisation of privies in Salford; but I had an opportunity of judging of its deodorising effects on excrement in the manufacture of manure from mixed excrement and charcoal which is carried on at the works of the Company. The deodorization is complete, but as the operations of the Company do not include the abatement of excrement nuisance in privies, although it contemplates the charcoal, from its peculiar cheapness, being put to this use, and seeks a market for this purpose, any further description of the Company's objects and work do not enter into my inquiry.

The Carbon Fertilizer Company also manufactures a cheap charcoal from seaweed, but in addition it uses this in a defined way for the abatement of excrement nuisance, and for the utilization of the excre-

* The dry-earth system had been adopted throughout the *Broadmoor Criminal Lunatic Asylum*, shortly before Dr. Buchanan's inquiry, in consequence of continued prevalence among the inmates of a peculiar form of "fever" so-called, supposed at first to have been dependent partly on defective sewerage arrangements, and partly on a water supply containing much vegetable organic matter. At the time of Dr. Buchanan's visit, the probability of defective sewerage having any part in the prevalence was believed to have been entirely set aside, and as his report shows, the nature and origin of the disease remained in obscurity. I am now able to state that, subsequently to Dr. Buchanan's inquiry, further doubts arising as to the sewerage of the asylum, and the "fever" persisting, a more searching examination was made, and defects so extensive discovered, that it was found necessary to reconstruct a considerable portion of the drains. With this reconstruction the recurrence of the "fever" ceased, and no cases have been recorded since 1870.

Charcoal System.

ment on a particular system. This system includes the charring of the excrement, after its first treatment with seaweed charcoal, so that the excrement itself may be made available in removing nuisance from excrement, and profitable as well in this way as from the chemical products distilled from it in the process of charring, or it may be converted into a valuable manure, or may be used in both these ways as proves best. The charcoal derived from the mixed charcoal and excrement is called by Mr. Edwd. C. C. Stanford, F.C.S., the inventor of the process, *Cycle*, or *X charcoal*. It increases in weight at each reburning by the amount obtained from the excrement; and it retains all the potash and phosphates of the excrement. From the volatilized products which pass off during the charring, and which include an inflammable gas of considerable illuminating powers, are condensed ammoniacal liquor and tar; and from the ammoniacal liquor sulphate of ammonia and acetate of potash are obtained. The cycle charcoal, although wanting nitrogen, has a high estimated value as manure, and when charged with the ammonia distilled from it during charring forms a manure of double the estimated value in its former state, and designated by the Company "nitro-carbon manure."

My observations were necessarily limited to the action of the seaweed charcoal as used for deodorizing excrement. The proportions of water, carbon, and ash in this charcoal as compared with wood and bone charcoal are thus given by Mr. Stanford:—

	Wood.	Sea-weed.	Bone.
Water	6·2	2·6	3·0
Carbon	92·0	63·0	9·2
Ash	1·8	34·0	87·8

Mr. Stanford observes on these results that seaweed charcoal resembles more the charcoal from bone than from wood, but that it differs from bone charcoal in containing more carbon and carbonates of calcium and magnesium, and less phosphates of these bases. It is noteworthy that in Mr. Stanford's experiments no difference was observed in the action of wood charcoal and bone charcoal upon organic matter, notwithstanding the great difference in the proportion of carbon in them.

I examined the action of the seaweed charcoal as applied to excrement under the following conditions:—

1. *Works of the Company at Dalmuir*:—(*a*) A closet attached to the office, used regularly by six or seven adult men, of which the receptacle had not been emptied for $2\frac{1}{2}$ years. This receptacle received the whole of the excrement and the greater portion of the urine, during business hours, of the persons referred to. The seat of the closet has a lever action, and on each use an ingeniously designed "chucker," fed from a hopper, scatters a suitable proportion of charcoal over the deposited excrement. A urinal is also placed in the closet, of which the basin is filled with charcoal, and which communicates with the closet receptacle. The receptacle was opened for my inspection. All excrement was completely covered, and the contents were dry and odourless. The contents were freely turned over with a spade at my desire, but no odour was given off during the process. (*b*) Twelve months' accumulation in a large shed of mixed charcoal and excrement of about equal bulks, from closets in various manufactories and houses on the Clyde and in Glasgow. This great mass was quite odourless, and a section cut into it showed excrement retaining its form and unchanged paper, but without a trace of smell.

Charcoal System.

(*c*) Another accumulation of mixed charcoal and excrement, which had been brought into the works a week before. This accumulation had a slight ammoniacal odour.

2. *Messrs. J. and G. Thomson's Ship Yard, Clyde Bank.* A privy of 36 seats, opening into a common vault, and used by 2,500 workers. The vault constitutes a chamber, entered by folding doors on the level of the ground, the closets forming a storey above, approached by stairs. The rule appears to be not to empty the contents of the vault until they approach the ceiling. At the time of my visit the vault was being cleared, and half the contents had been removed, leaving a section of the undisturbed half extending from floor to ceiling. Notwithstanding this newly exposed surface of the still great mass, there was no offensive odour, except in one or two spots where from careless use of closet, or an empty hopper, a portion of uncovered fresh excrement lay. The mechanism of the closets was similar to that already described.

3. *Smallpox Hospital, Glasgow.*—Here the charcoal is used with pail-closets, and for the close-stools in the wards. In the closets a box with scoop is placed on the seat, and the nurse is held responsible for covering the excrement deposited. Where this was properly done, the deodorization was complete. The use of the charcoal in the close-stool was said to be to some extent objectionable, from the difficulty of cleansing the vessels after its use, and from the amount of slop arising from this process which had to be cast into the closet-pail. The contents of the pails are deposited in a shed within the hospital inclosure, and removed at intervals of three weeks to Dalmuir. The deposit in the shed at the time of my visit was odourless, but moist when turned over. The hospital contained 100 patients, and 26 cwts. of charcoal were supplied to it twice a week. This was abundant for the requirements of this number of patients, but when the number had exceeded 200, some little difficulty had been experienced in obtaining a sufficient supply of charcoal.

4. *Bowling-Green Terrace, Glasgow, Stair,* No. 4.—The closets in this and adjoining stairs in the terrace have been built to communicate by shafts (a filthy arrangement) with a common receptacle in the basement. They were designed for dry-ash closets, and the closets of one stair have been converted into charcoal closets. Although the mechanism of one closet was broken, and the closets were dirty, there was no excremental smell from the shafts. But the inhabitants of the stairs complained of occasional smell when the receptacle had been long unemptied. The receptacle of the ash closets on an adjoining stair, it must be stated, was also almost free from smell, other than that of the ashes and dry-house refuse.

5. *The Quay, Glasgow.*—Two large public closets, one a Macfarlane's trough, without water, cleansed every alternate day; the other managed with charcoal, and containing a great accumulation in its pit. The former closet stunk unbearably, the latter had only such stink as came from excrement deposited since the last distribution of charcoal by the man in charge, this being effected several times daily. The former in fact was a public nuisance, the latter an unnoticeable convenience.

The quantity of charcoal needed for the efficient deodorization of excrement is stated to be by weight one-fourth that of dry earth; and upon this estimate the supplies of the Company to the various closets to which they furnish charcoal have been calculated. Mr. Stanford, taking the total excremental matters to be removed per

head from a household annually to be 8 cwts. (of which $\frac{3}{4}$ cwt. would be solid excrement), estimates that the quantity of charcoal required for the deodorization and utilization of a family of 10 persons would be about 4 tons yearly, and that the amount of material to be removed, making allowance for drying of the mixed excrement and charcoal, would be between five and six tons in weight. The Company contemplates the cleansing of the closet at long intervals, say once a year.

Charcoal System.

The examination of the charcoal closets in Glasgow and the vicinity proves, as was to be anticipated, that charcoal properly applied acts as a most effective deodorizer of excrement, and that this action, in receptacles kept dry, persists for an indefinite period. The assumption, however, that the mixed excrement and charcoal may, therefore, be safely stored for many months in the vicinity of or within the precincts of dwellings, appears to me to be at least premature. We know too little yet of the modes in which excrement acts in the production of disease to justify such assumption ; and we are not less ignorant of the action of charcoal upon the disease-producing qualities of excrement. Mr. Stanford's researches on the mode of action of charcoal on organic matter, suggests extreme caution in our conclusions on this subject. He believes, from his experiments, that the charcoal acts not as an oxidising agent, but simply as a drier.* The possible changes in a mixed mass of excrement and charcoal which may occur under various conditions of moisture and temperature are as yet wholly unknown.

But apart from these considerations there is the simpler question of the success which would probably be obtained among a mixed population in the ordinary use of charcoal as a privy deodoriser. The experience of Glasgow, even to the present time, shows, that there is no such surety of action to be obtained in this respect as Mr. Stanford and his Company contemplates, and that notwithstanding the great advantages accompanying the use of charcoal in deodorising excrement, the frequency of its removal from houses should be governed by other and wider considerations.

At the time of my visit to Glasgow, the Company had entered into a contract with the Corporation of Oldham to apply its process to the disposal of excrement in that borough. The preliminary arrangements for carrying out this contract had not been completed when this inquiry came to an end.

Slop Nuisance.

Slop Nuisance.

The abatement of nuisance from slops, including under that term the whole liquid refuse of a household, is part of the wider question of the disposal of sewage. The same principles apply in dealing with slops as with sewage, the two subjects merging the one into the other. Certain typical methods of slop disposal, here described, came under observation during this inquiry.

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* "On the Action of Charcoal on Organic Nitrogen," *Journal of the Chemical Society*, January 1873.

1. In certain new cottages at Halton (Bucks), on the estate of Sir Anthony de Rothschild, the slops are conducted by a drain to a small water-tight receptacle in the garden, whence it is proposed that they shall be ladled from time to time for garden purposes. These cottages are provided with earth-closets, and each cottage has attached to it 40 poles of garden ground. It is calculated that the manure from the earth-closets and the slops may be all utilized in gardening this plot.

2. Another method of disposal is followed at the cottages of the Industrious Aid Society, Hereford. Here sub-irrigation is used to get rid of the slops. Each cottage has a garden-plot of a sixth of an acre, and in this plot sub-irrigation drains are laid for the slops, with small catch-pits at intervals. The slops, however, except when in large quantities, as the contents of a washing tub, penetrate but a very short distance into the drains. The porous loamy soil readily absorbs the liquid and no nuisance arises. Earth closets are attached to these cottages, as already described in the section on the Dry-Earth System.

3. A third method of disposing of liquid house refuse combines the two former methods, developing the first described into a system. This has been devised by the Rev. Henry Moule, M.A., vicar of Fordington, Dorsetshire. Mr. Moule, whose name is commonly associated solely with the dry-earth system of excrement disposal, has by no means limited his attention to that system alone. The dry-earth system, indeed, is perhaps most correctly described as a part of a more general scheme, which Mr. Moule is engaged in maturing for dealing with the whole refuse of a household. As part of this scheme I witnessed in a small plot of garden attached to his house the successful disposal and utilization of the whole of the liquid refuse of the household. This refuse flows to a catch-pit in the garden, which has an overflow into a sub-irrigation drain. The garden is cultivated by alternate cropping, the only manure applied to it being the fresh slops, which are ladled from the catch-pit and distributed to the garden daily. Luxuriant successive crops of garden vegetables are obtained in this manner, and Mr. Moule is of opinion, as the result of his experiments, that the liquid refuse of a family of from 17 to 20 persons can be thus profitably used on five or six perches of ground, as many as three or four crops being grown yearly. The following illustration of Mr. Moule's procedure may be given: On two perches of ground from which potatoes had been removed, drills were run, and after these had been saturated for two days with slops, brocoli was successfully transplanted to them in blazing sunshine. Then between the drills holes were made to the depth of 10 inches and prepared for subsequent transplantation of cabbages by filling them again and again with slops. Meanwhile on both sides of each row of holes a row of autumn carrots was sown.

So far as this inquiry was concerned the method described appeared to be a very feasible way of obviating nuisance from slops where garden ground and intelligent labour were available for its adoption.

4. A fourth method of disposal of slops, in which the difficulty of sub-irrigation by gravitation from the ordinary flow is overcome, has been invented by Mr. Rogers Field, C.E. Mr. Field is the owner of two cottages, at Shenfield, near Brentwood. When these cottages came into his possession they had much adjacent nuisance from their privies, and from the accumulation of slops in contiguous ditches. Mr. Field converted the privy pits into smaller watertight receptacles, with the object of their being used as earth-closets, but he failed, from inability to exercise frequent supervision, to induce the cottagers to use the earth. He succeeded, however, in preventing soakage

of excremental matters from the privy-pit into the ground and in diminishing considerably their accumulation, and the nuisance therefrom. For some time he was puzzled in what manner to get rid of the slop nuisance, the irregularity and smallness of the flow foiling him in an attempt to direct it a sufficient distance along subsoil drains for any useful purpose and for the complete avoidance of nuisance. At length he devised a plan of accumulating the slops in a tank and discharging them at intervals rapidly by means of a siphon. The kind of tank first designed, and of which a pair have been in action at the cottages in question over six years, is shown in the accompanying drawing (Fig. 12). When this tank is full, a little additional slop thrown down

Fig. 12.

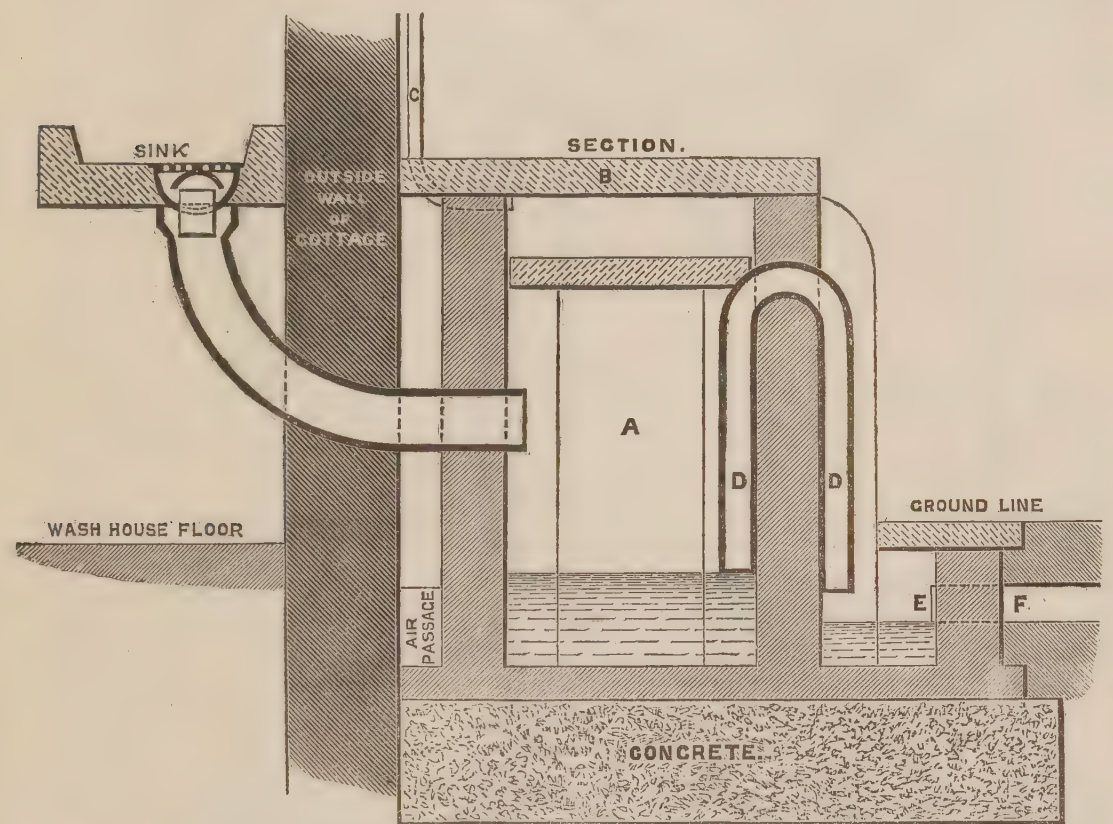


Fig. 12, A, a tank of about 33 gallons capacity, covered with moveable stone cover B, and provided with a ventilating pipe (C), which is carried up the outside of the cottage. The outlet from this tank consists of a siphon pipe (D), so arranged that when the liquid in the tank rises above the top of the siphon, it becomes charged, and empties the tank very rapidly. As soon as the sewage is lowered to the level of the bottom of the siphon (which is a short distance above the bottom of the tank, so as to leave a space for the deposit to be cleared out periodically), the siphon is thrown out of action, and allows the tank gradually to fill again with sewage. The siphon discharges through a small well (E) into a drain (F) leading to the sub-irrigation drains, which latter consist of common 2-in. agricultural drain-pipes laid about 12-in. below the surface of the cottage gardens.

the sink starts the siphon in action, and the contents are emptied with sufficient rapidity and force to carry them a considerable distance along the drains attached to the tank.

The action of this tank, as far as the abatement of slop nuisance is concerned, has been complete, and except an occasional cleansing at somewhat long intervals, and an examination of the drains with which it is connected in order to obviate any stoppage, its operation has involved no trouble. But sundry defects in the action and arrangement of the tank were brought to light by experience. The point of entrance of the sink drain was undesirable, the slops backing up in the drain as the tank filled, and the water from the bell-trap of the sink being

occasionally emptied by the suction action of the siphon. It was objectionable also that urine from the bed-chamber and in chamber slops could not be poured into the tank except from the sink. Again, the quantity of water required to start the siphon when the tank became full was too large, and it happened that smaller quantities thrown down the sink at this time would simply cause an overflow through the siphon, the slops dribbling away until their level in the tank fell to the level of the siphon's bend. These defects have been remedied by Mr. Field, and the flush-tank as now designed and fabricated in iron

Fig. 13.

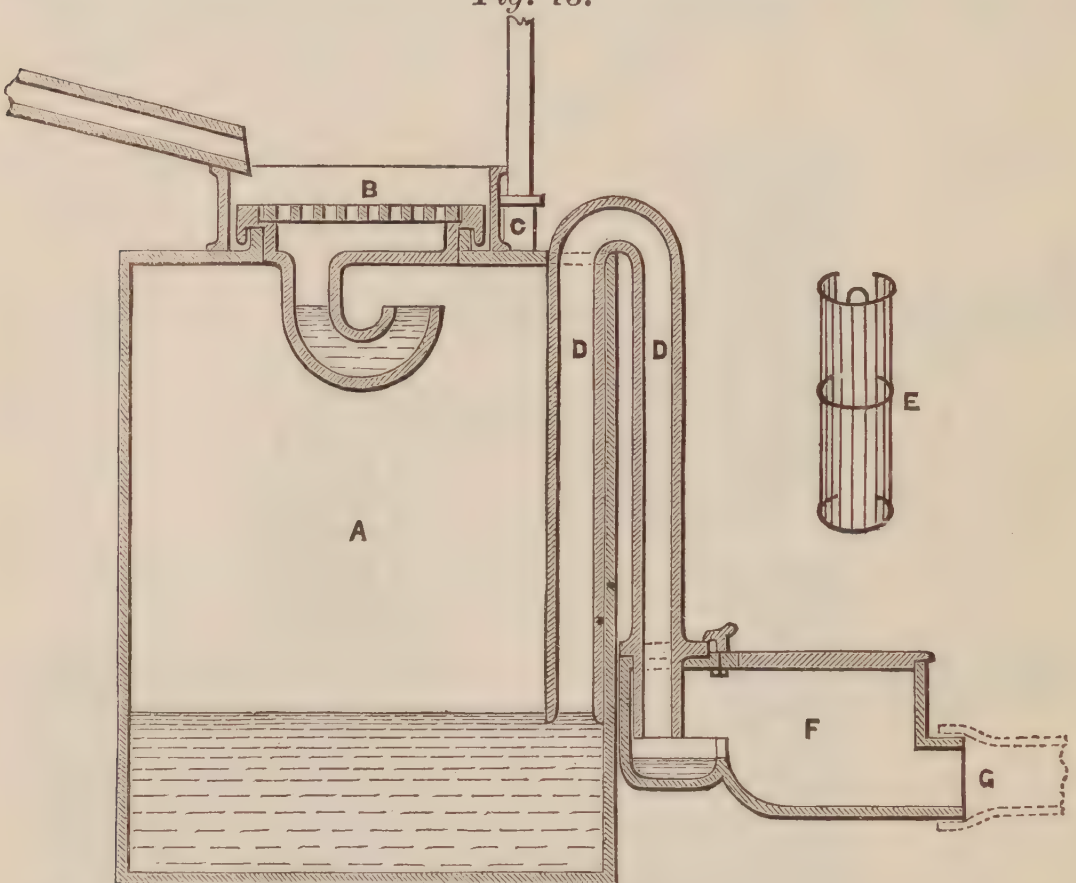


Fig. 13. This apparatus consists of a cylindrical watertight iron or stoneware tank (A). This tank has a trapped inlet (B), which also forms a movable cover to give access to the inside of the tank, and a socket (C) for a ventilating pipe. The outlet consists of a siphon (D), so arranged that no discharge takes place till the tank is completely filled with liquid, when the siphon is brought into action and the contents are immediately discharged. The inner end of the siphon is protected by a wire strainer (E), and the outer end enters a discharging trough (F), which is made to turn round so that its mouth may be directed as required to connect the tank with the line of outlet pipes (G). This trough has a cover which can be removed to give access for cleaning.

or stoneware, appears to be perfect in action. A drawing of this tank is given in Fig. 13.

It will be observed in this figure that the sink drain opens outside the tank above a trapped inlet; and that the long limb of the siphon terminates in a small trough. This trough is so arranged that any trickle of slops along the siphon quickly closes the outlet; and continuation of the trickle after this closure, from air contained in the siphon being carried along with the liquid, exhausts the siphon sufficiently to cause it to be brought into action by the preponderating atmospheric pressure upon the surface of the liquid in the tank. By this ingenious arrangement a much less quantity of liquid thrown down the sink will start this siphon in action than in the tank first designed, and abortive flow from the tank is obviated.

The flush-tank is made of different sizes, varying in capacity from 16 to 30 gallons, exclusive of space for deposit. When in continuous use

the interior should be cleansed and the deposit (a useful manure) removed every month.

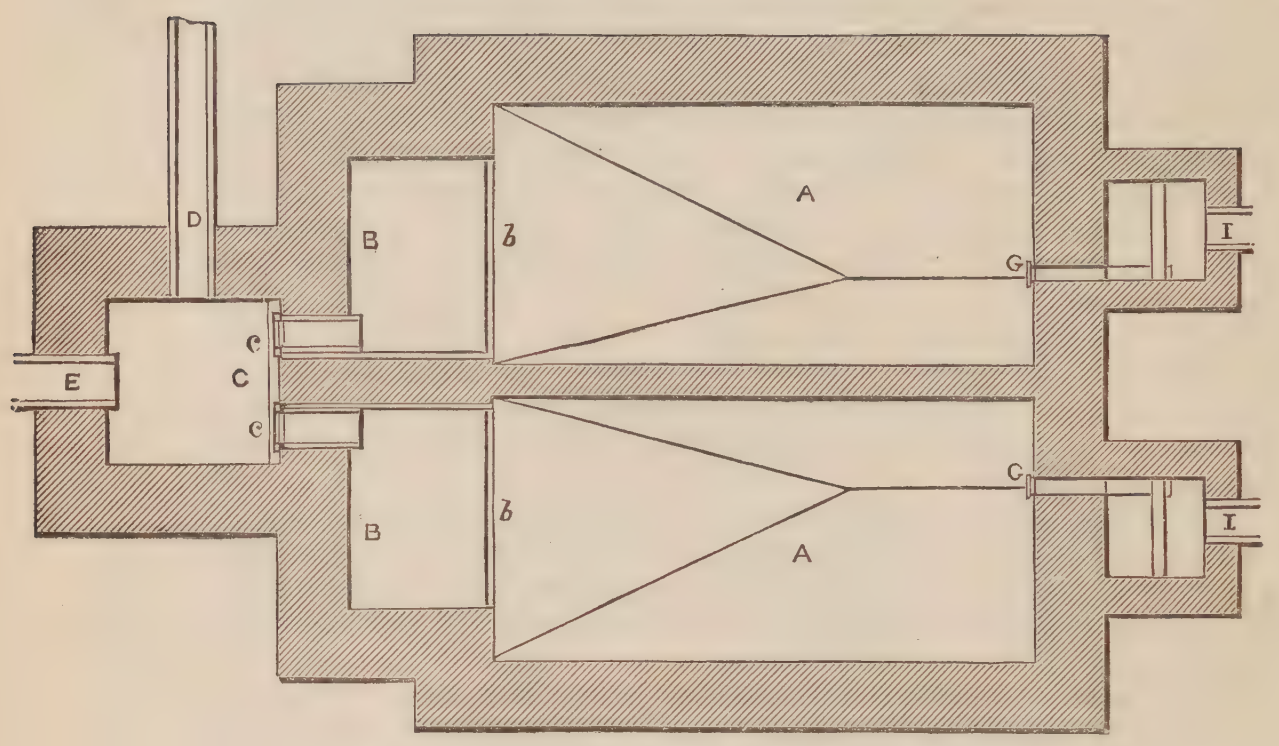
I subjoin a plan of the cottages at Shenfield and the arrangements of their drains. (*Plate* XXXV.) The sub-irrigation drains, formed of 2-inch agricultural pipes, are laid, at a depth of about 12 inches, upon a bed formed of larger agricultural pipes divided longitudinally in half. If this bed be properly arranged by a skilful workman in the first instance, subsequent examinations and replacing of the drain for the purpose of removing stoppages (which should be done every twelve months) may be effected by an ordinary labourer. The sub-irrigation drains are connected with the flush-tank by a longer or shorter portion of water-tight drain, according to the position of the irrigated land with reference to the house. In cases where it is requisite to prepare the soil first for irrigation by subsoil drainage it is necessary in laying the drains for sub-irrigation with slops so to place them that their contents may not pass unaltered into the land drains. It is also necessary, for the same reasons, to give regard to their relation to wells used for drinking purposes or cooking.

Each of the gardens attached to the cottages at Shenfield measures 7 perches ; but Mr. Field is of opinion, from the experience of the flush-tank at these cottages, that four perches would be sufficient ground for the effective disposal and utilization by sub-irrigation of the slops from an ordinary cottage.

The foregoing invention for separate houses has been further developed so as to meet the general wants of a community by Mr. J. Bailey Denton, C.E., in conjunction with Mr. Field. The same difficulties have been experienced in dealing with and utilizing readily, economically, and inoffensively, the liquid house refuse of villages and towns, as with that of separate houses, and from the same causes, the ordinary insignificance, and occasional irregularities of flow. To meet these difficulties Messrs. Bailey Denton and Field have designed a tank termed by them "*The Automatic Sewage Meter*," which is constructed on the same principles as Mr. Field's self-acting flush-tank. This "meter" provides for the accumulation of the liquid refuse and for its automatic discharge, at definite intervals, in quantities admitting of distribution over land by gravitation, for purposes of irrigation. A meter of this kind has been in use about three years in the hamlet of Eastwick, near Leatherhead, in Surrey, and its operation, particularly as part of the sanitary arrangements of the village, may there be studied very usefully.

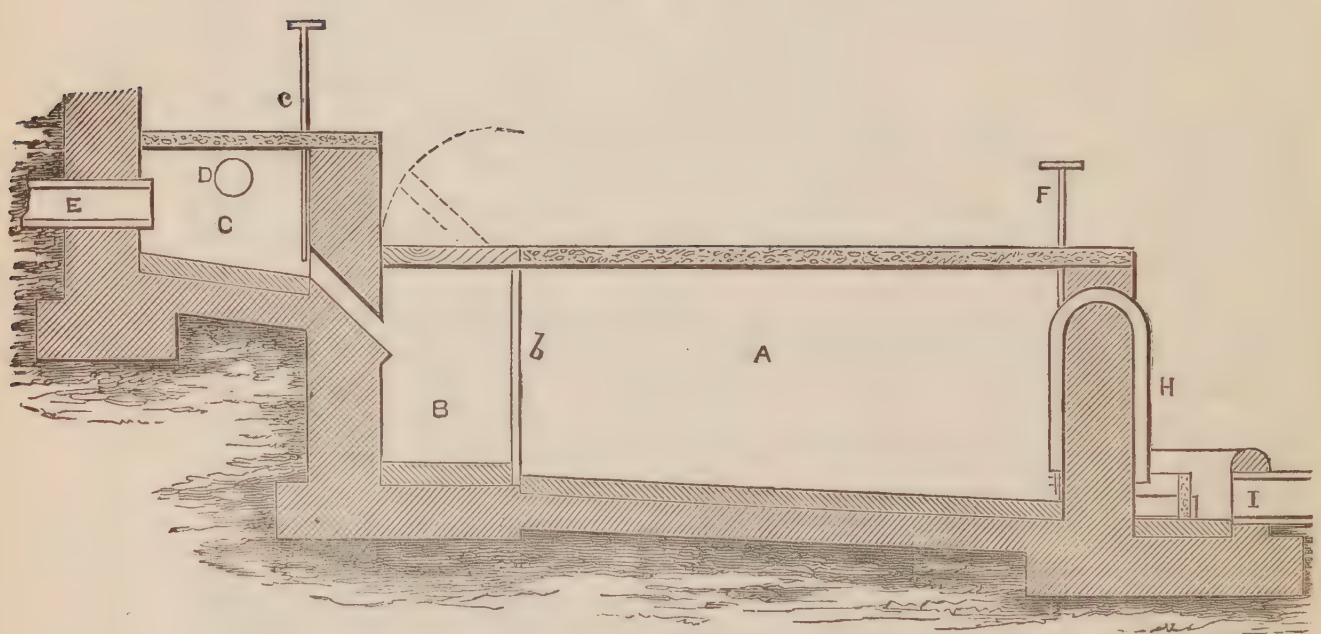
Eastwick is a hamlet of 13 houses, including the mansion of the proprietor and the farm homestead ; and it has a population of about 145. In devising a system of excrement and slop disposal for the place, any general plan of water sewerage had to be set aside, the water supply derived from wells being variable in quantity, and at no time too abundant for ordinary domestic use, irrespective of waterclosets. The common privy was retained for the cottages, but the privy-pit was converted into a water-tight receptacle beneath the floor of the closet, and the cottagers were instructed to throw into it above the excrement the refuse ashes, and to remove the contents of the pit monthly for use in their gardens. Four waterclosets exist and five earth closets for the use of the mansion and its precincts ; and one watercloset and three earth-closets for the use of the farm homestead. To provide for the liquid house refuse of the hamlet, and for the drainage of the farm buildings, the scheme of sewerage was carried out by Mr. Bailey Denton which is shown in the accompanying plan (*Plate* XXXVI.), and which has an outlet in a meter tank, of which the plan and section are given in the following figures (Figs. 14 and 15).

Fig. 14.



The Automatic Sewage Meter-tank (plan).

Fig. 15.



The Automatic Sewage Meter-tank (section).

Figs. 14 and 15, A, the meter-tank ; B, the straining chamber ; *b*, the strainer; C, sluice chamber, with sluices, *c*, governing communications with straining chambers ; D, overflow ; E, sewer; F, sluice for draining off sediment through the pipe G ; H, siphon; I, delivering pipe.

The tank is in two compartments, to admit of cleansing without entire disuse. It has a capacity of 500 gallons, and it fills and discharges in ordinary dry weather three times in two days. The several discharges are directed successively on different portions of a plot of ground prepared for the purpose, and which measuring 3 roods 3 perches serves ordinarily for the effective and profitable utilization of the whole liquid refuse of the several cottages, the mansion, and the farmstead. The drainage of the latter includes the flow from cattle sheds and stables, in which from 15 to 20 animals are always present, and about 30 head of horned cattle, and 30 horses at intervals. The drainage of a large piggery also passes to the tanks.

Luxuriant crops have been grown upon the irrigated land, last year's crop consisting of the thousand-headed cabbage. Of this crop, Mr. Hutchinson, the steward of the estate, says:—"Besides thriving so well "upon the sewage, it is an excellent food for milk cows, being less "strong in taste than the drumhead and not having any but a good "effect upon the milk. The thousandhead can also be used as human "food. I estimate the value of the crops obtained at 25*l.* per annum, "or at the rate of 32*l.* 10*s.* per acre; and the outlay in attendance "upon the land and the regulator ("meter") I put down at 7*l.* 16*s.*"

Mr. Bailey Denton, to whom I am also indebted for the plan, has courteously sent me the following statement of the cost of the works above described, including the "meter" and the preparation of the land, and he remarks upon this statement that:—"the yearly return, "after deducting the cost of attendance upon the sewaged land and "regulator cannot be less than 17*l.* per annum, so that already a return "of about 5 per cent., on the outlay is gained, while there is every "prospect of increasing that return as the quantity of sewage dealt "with becomes greater and its treatment becomes better understood."

Eastwick Sewerage.

	£	*s.*	*d.*
To payment for labour - - - -	179	4	0
„ „ pipes - - - -	103	7	2
„ „ stone, lime, cement and sand -	12	14	0
„ „ iron and lead work - -	20	5	1
„ „ carriage of materials - -	1	9	1
Travelling and incidental expenses - -	3	12	0
	320	11	4

In regard to abatement of slop nuisance, and I may add also largely of farm nuisance, among a rural community, the arrangements at Eastwick are the most complete and satisfactory I have yet seen. Notwithstanding the contiguity of the irrigated land to the mansion, no nuisance is experienced from it, whereas previous to the present arrangements, when the slops of the mansion and cottages found their way into neighbouring ditches and decomposed there, considerable nuisance had existed. With some structural alterations in the privies (the principles of which are stated in their proper place in this report) and such needed supervision as will now be obtained from the Sanitary Authority appointed under the Public Health Act, 1872, the arrangements at Eastwick may be regarded as a pattern to be followed by villages and small towns similarly circumstanced.

Slop Nuisance.

From what has already been said it may be inferred that the "Auto-"matic Sewage Meter" admits of wide application in removing the difficulties which often beset the disposal of the sewage of communities larger than Eastwick. It simplifies the whole question of dealing with the sewage of small towns, villages, isolated institutions, and mansions, while securing the most efficient application of the sewage to land, both for purification and utilization, with the least expenditure of labour.

5. In my observations under the head of Gloucester, I have referred to certain experiments of Dr. Francis T. Bond, on the depuration of slops by a combined process of straining, chemical precipitation, and filtration. These experiments should be had in mind as at least giving promise of successful dealing with slop-nuisance under conditions to which the simpler methods already described might not be applicable.

The various methods of slop-disposal which have been described meet the greater number of the conditions under which slop-nuisance is apt to occur. With the exception of Dr. Bond's method, all dispose of the slops by distributing them to the soil either upon or beneath the surface, or in both ways, intermittently—in other words, by intermittent irrigation.

J. Netten Radcliffe.

31st December 1874.

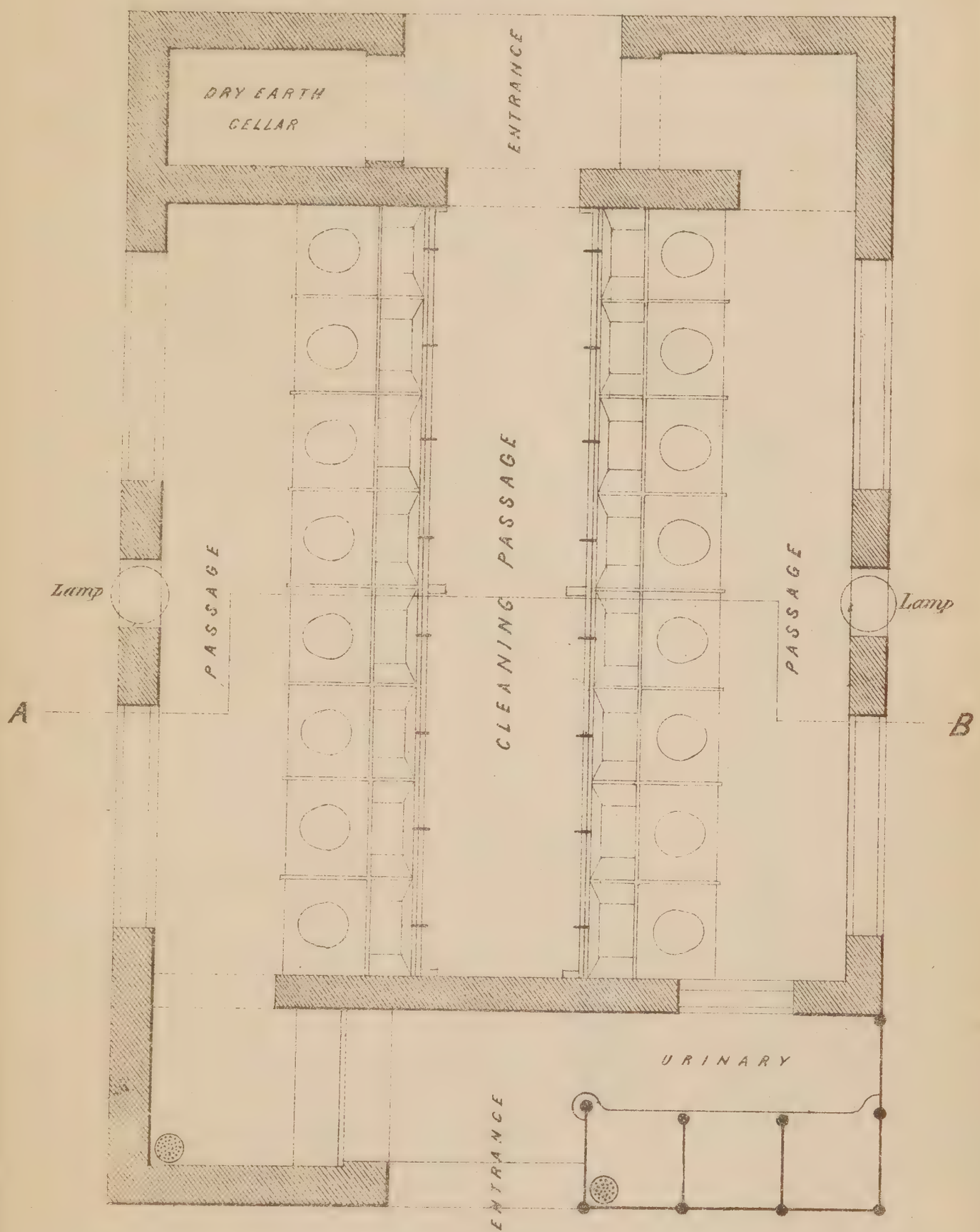
LONDON:
Printed by George E. Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

EDINBURGH CORPORATION.

No 1

Dry Earth Closet in Burnet's Close.

EDINBURGH.



SCALE

INS 12-9 6 3 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 FEET

BURGH ENGINEER'S OFFICE,
Edinburgh, 8th Sept 1874.

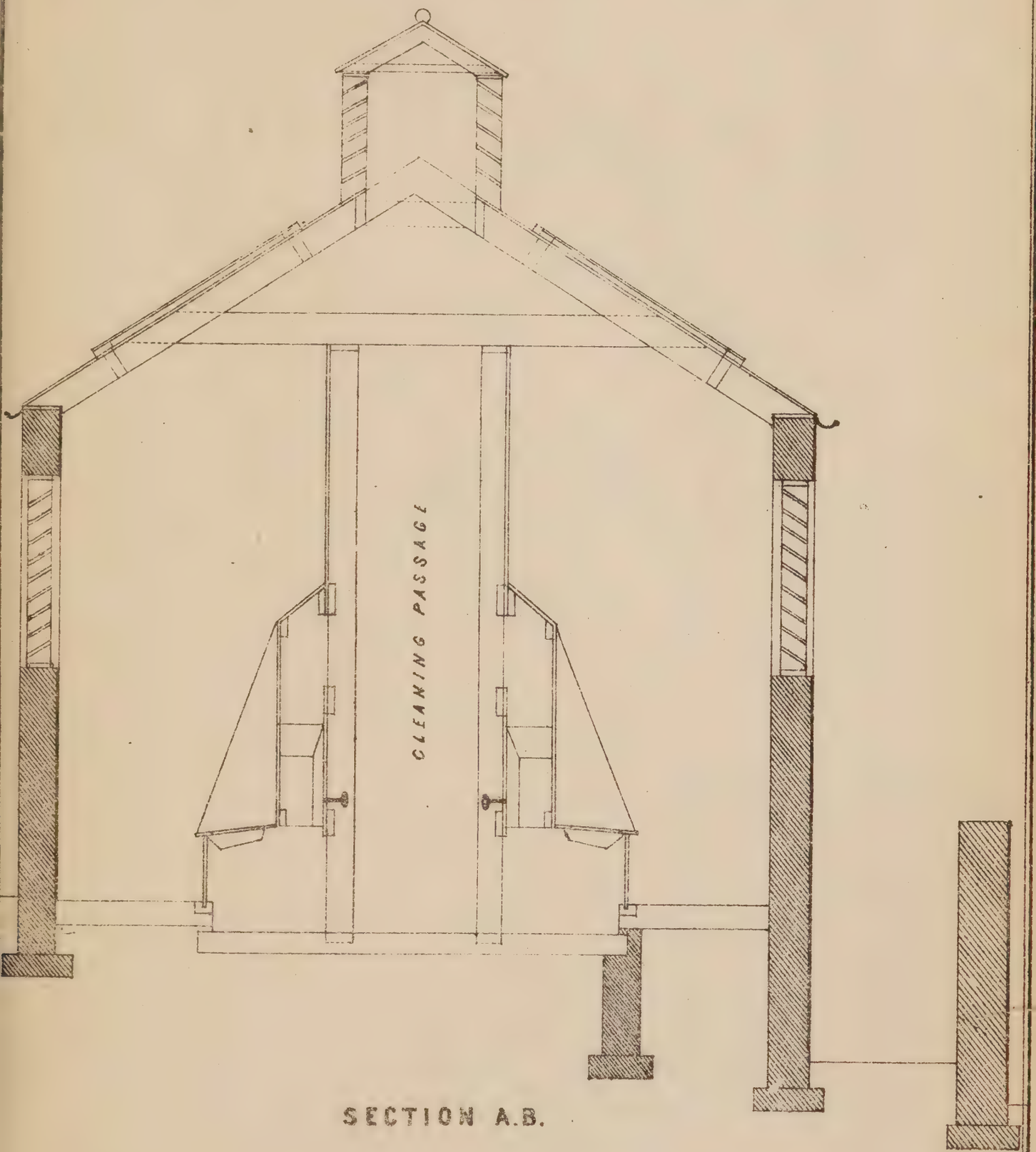
Dangerfield Lith London

18 MAY '32

Nº 2.

EDINBURGH CORPORATION.

Dry Earth Closet in Burnet's Close,
EDINBURGH.



SECTION A.B.

SCALE

INCHES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 FEET

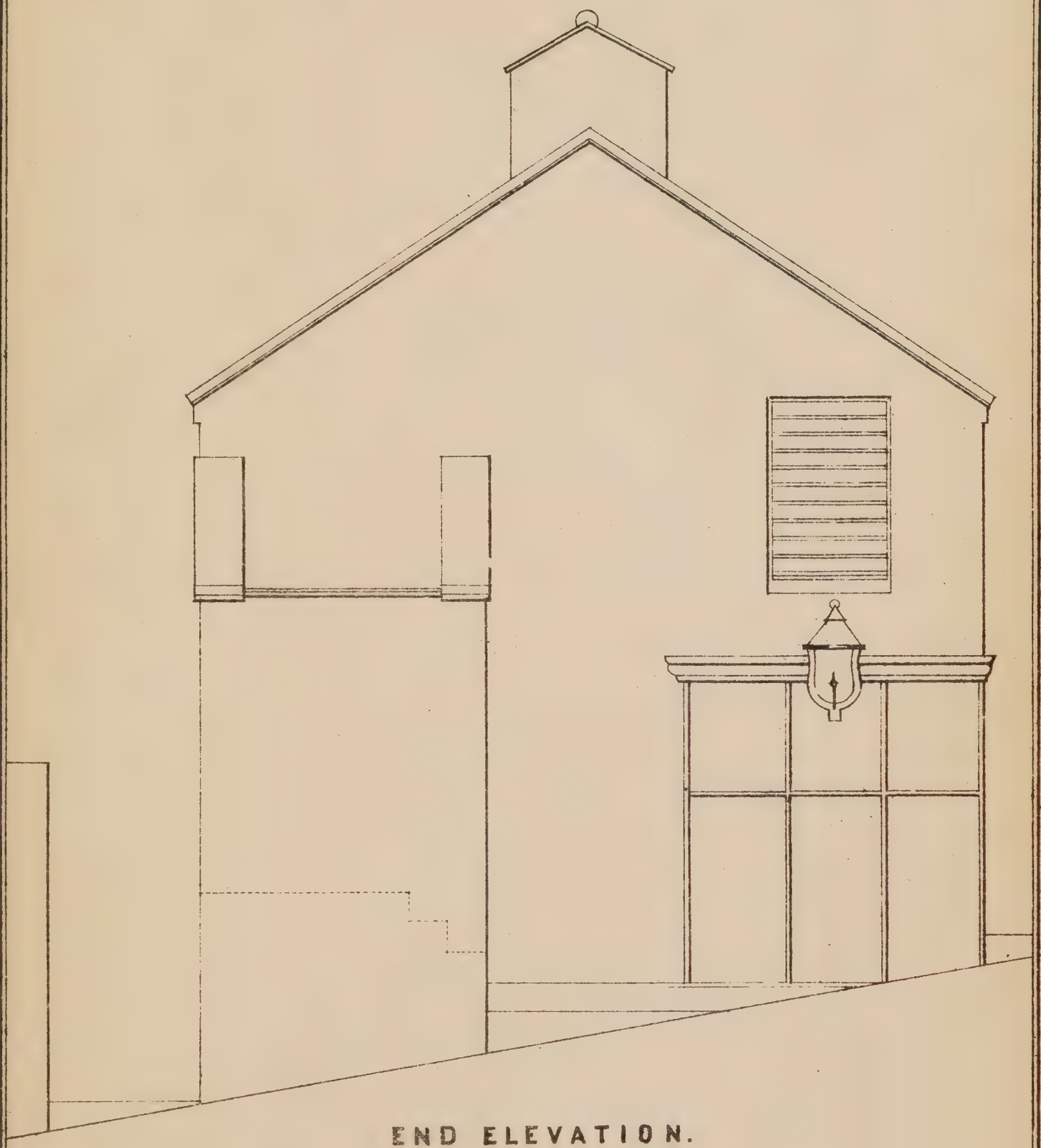
BURGH ENGINEER'S OFFICE,
Edinburgh 8th Sept. 1874

Dangerfield Lith. Ld.

N° 3

EDINBURGH CORPORATION.

Dry Earth Closet in Burnet's Close,
EDINBURGH.



END ELEVATION.

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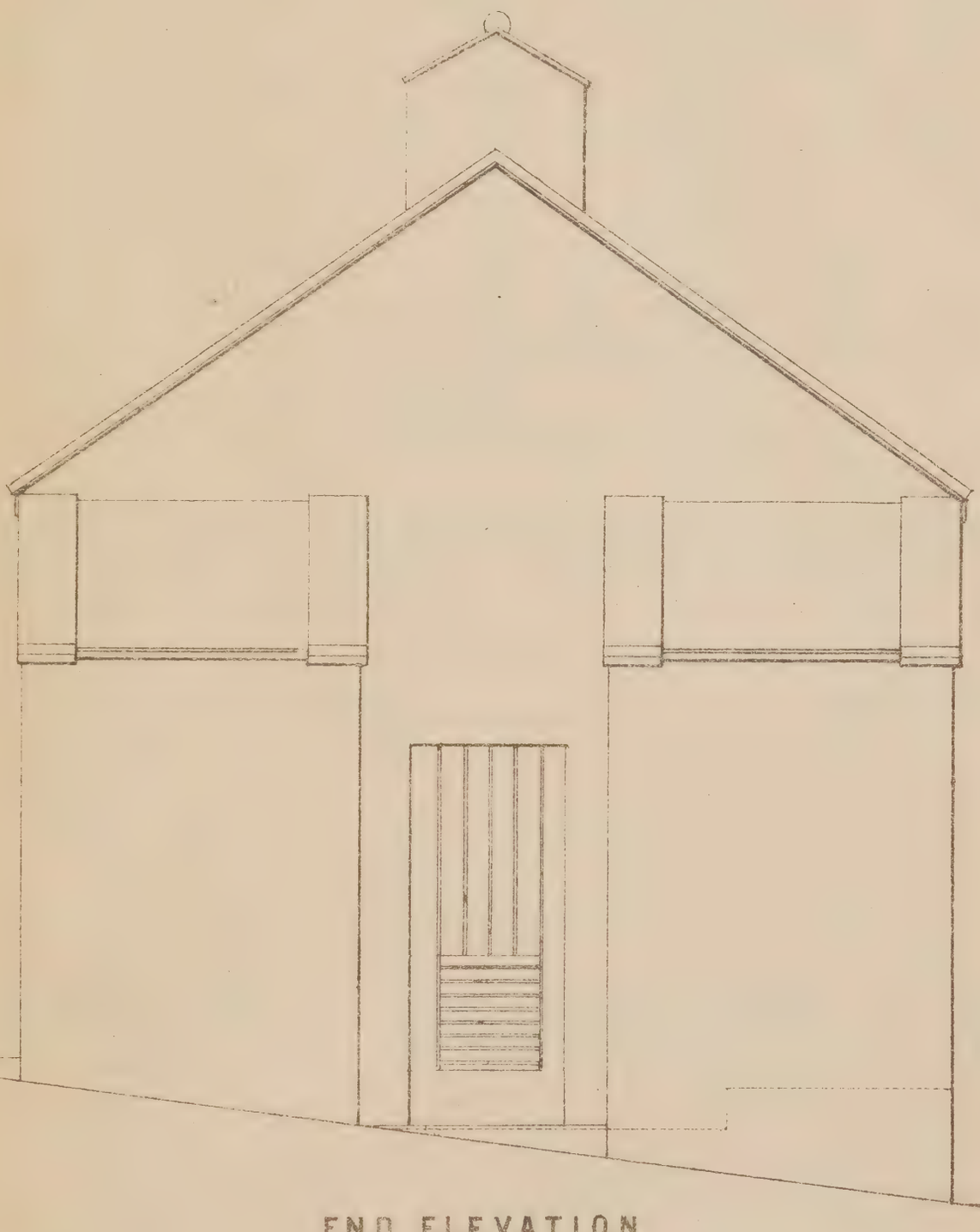
BURGH ENGINEER'S OFFICE,
Edinburgh, 8th Sept.r 1874.

Dangerfield, Lith. London

EDINBURGH CORPORATION.

No 4.

Dry Earth Closet in Burnet's Close,
EDINBURGH.



END ELEVATION.

SCALE

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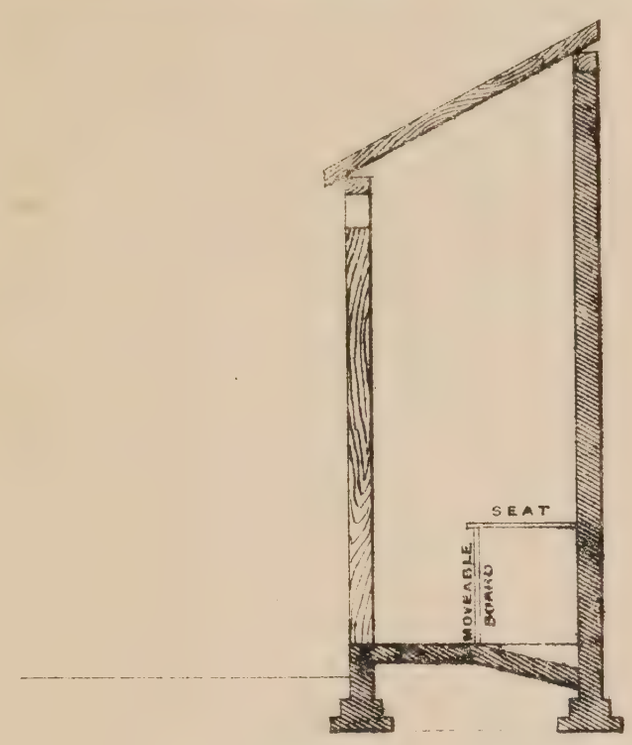
BURGH ENGINEER'S OFFICE,
Edinburgh 8th Sept. 1874.

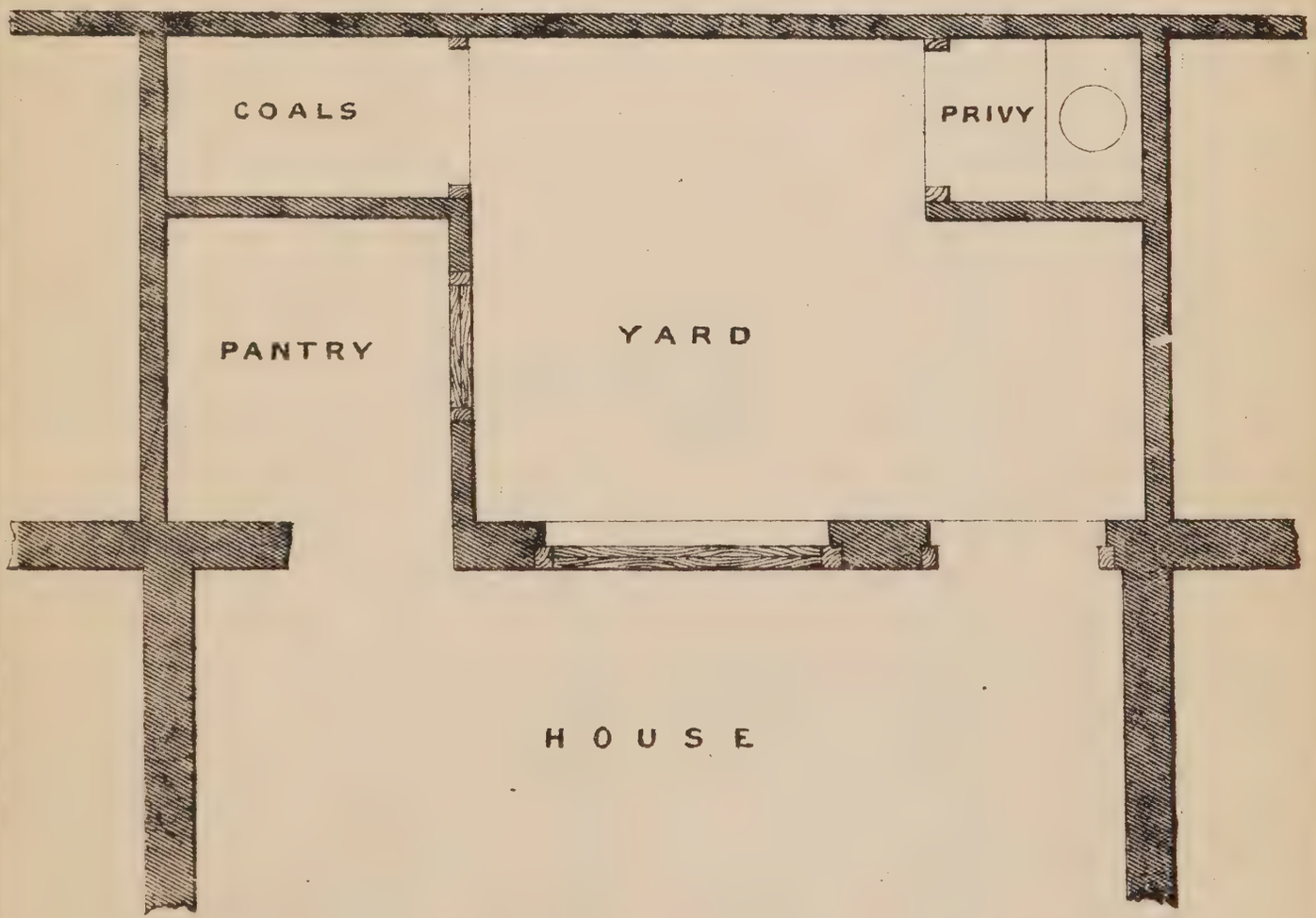
Dangerfield, Lith London

HULL.

APPROVED CONSTRUCTION AND ARRANGEMENT OF ORDINARY PRIVIES WITH PLAN SHOWING THE SMALLEST YARD SPACE ALLOWED IN NEW HOUSES.



SECTION OF PRIVY



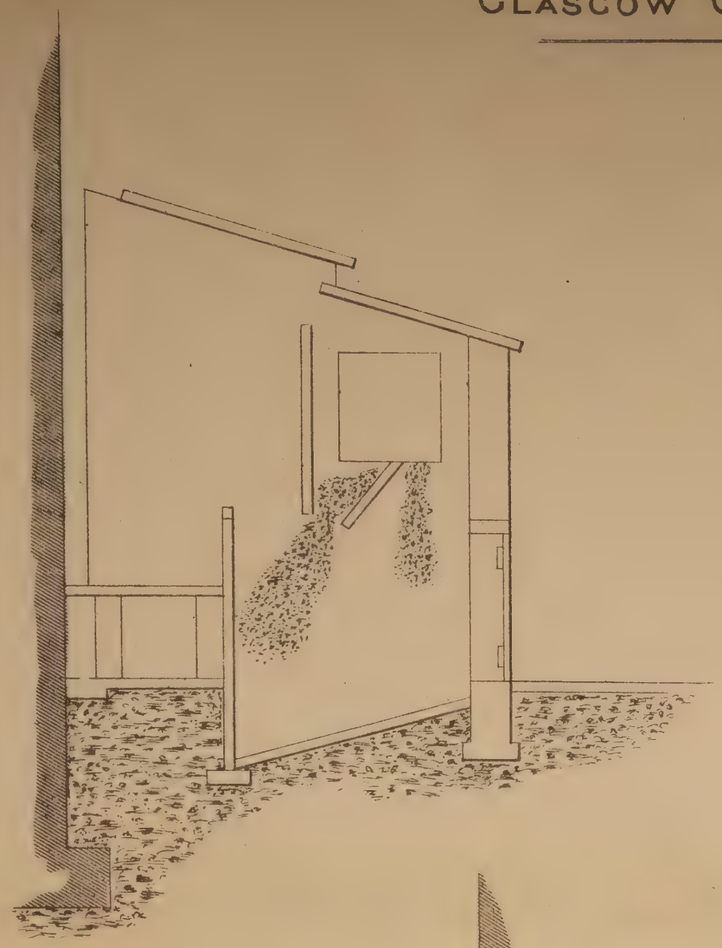
Scale 4 Feet to an Inch.

Dangerfield, Lith. London.

Nº 1.

PLAN OF PRIVY AT Nº 24 WILSON Sᵀ

GLASCOW CORPORATION.



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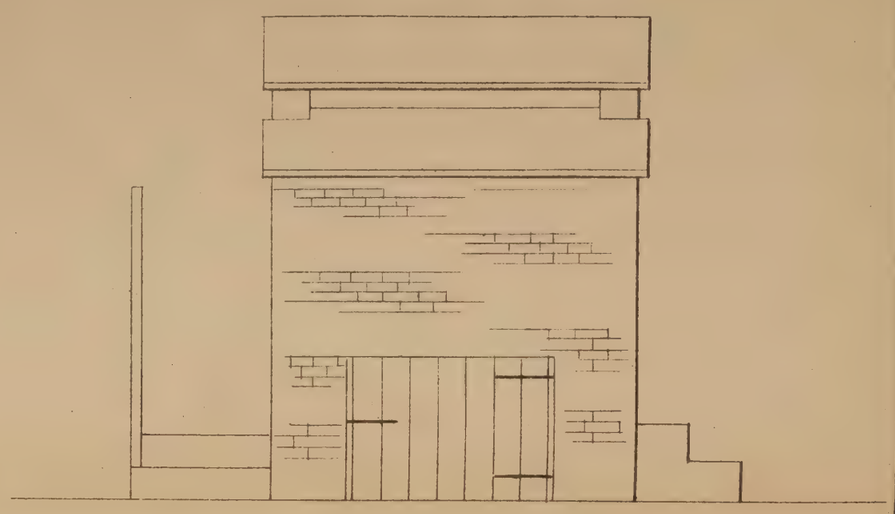
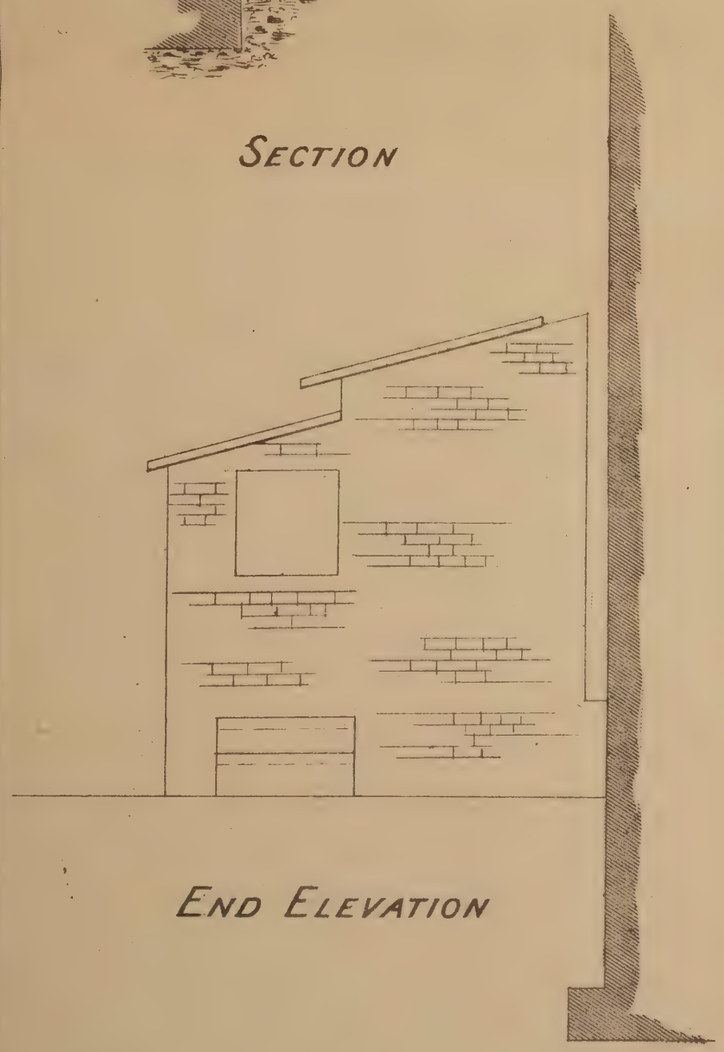
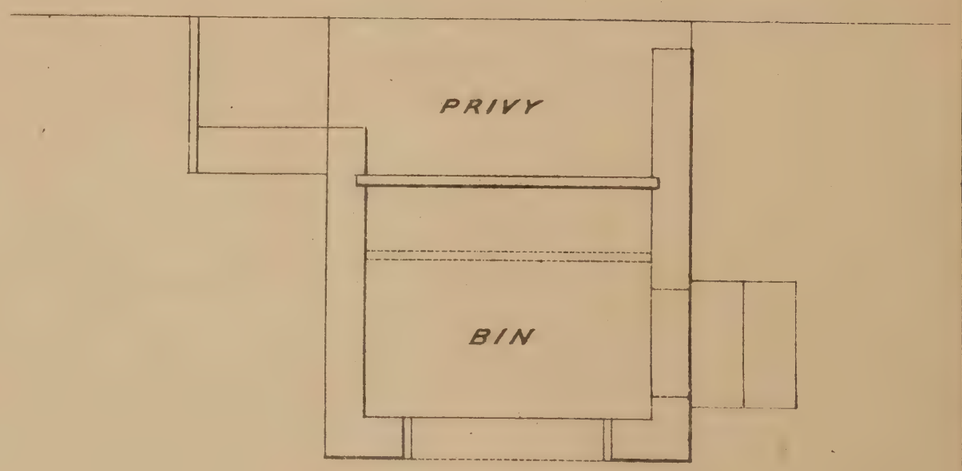


ELEVATION



END ELEVATION



PLAN

10 5 0 10

SANITARY CHAMBERS.

Nº 1, Montrose Street,

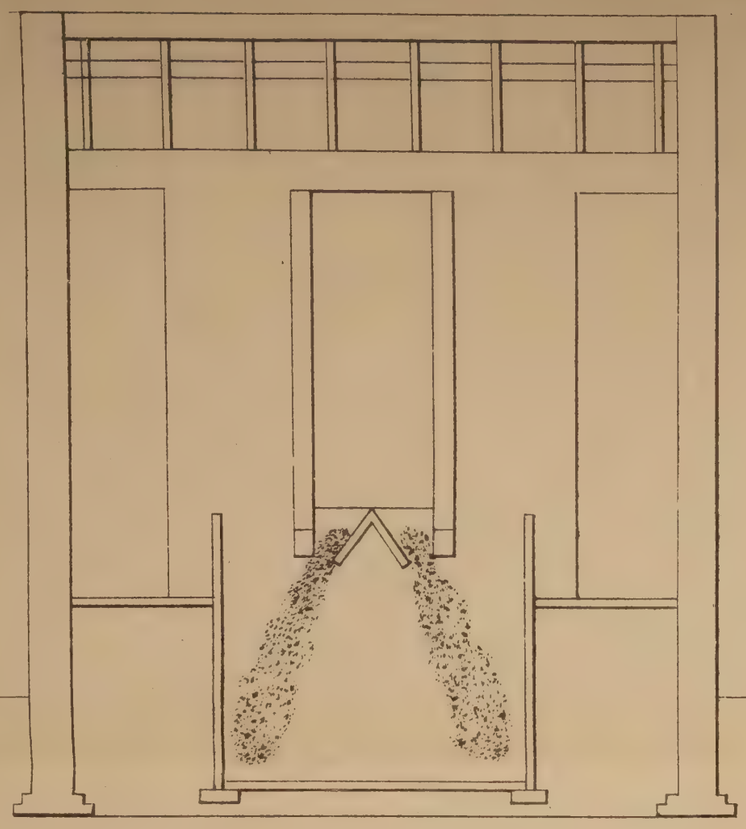
GLASGOW.

Dangerfield, lith. 22, Bedford St. Covent Garden

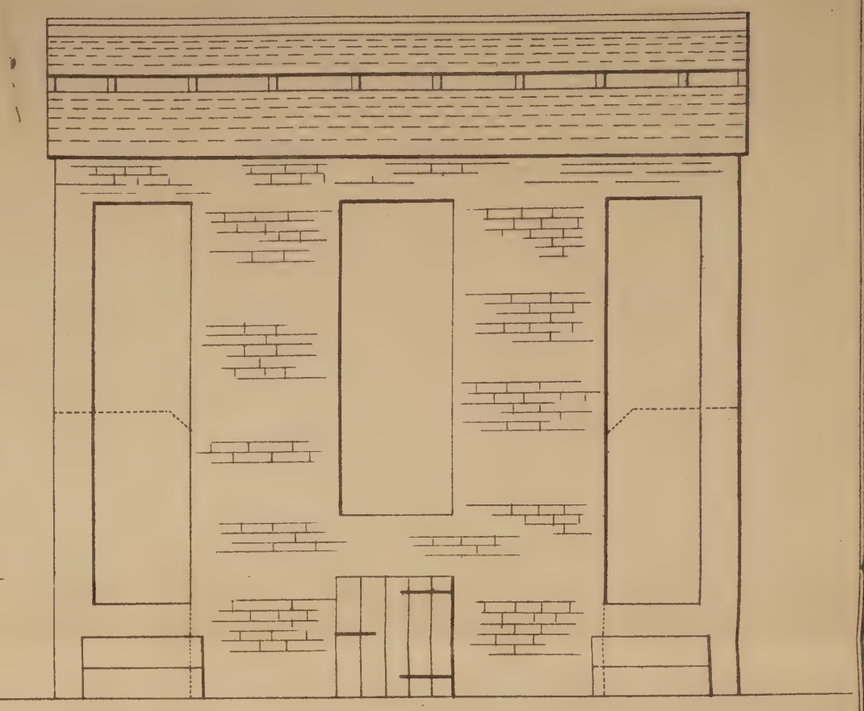
Nº 2.

PLAN OF PRIVY AT 25 AND 33 TRONCATE.

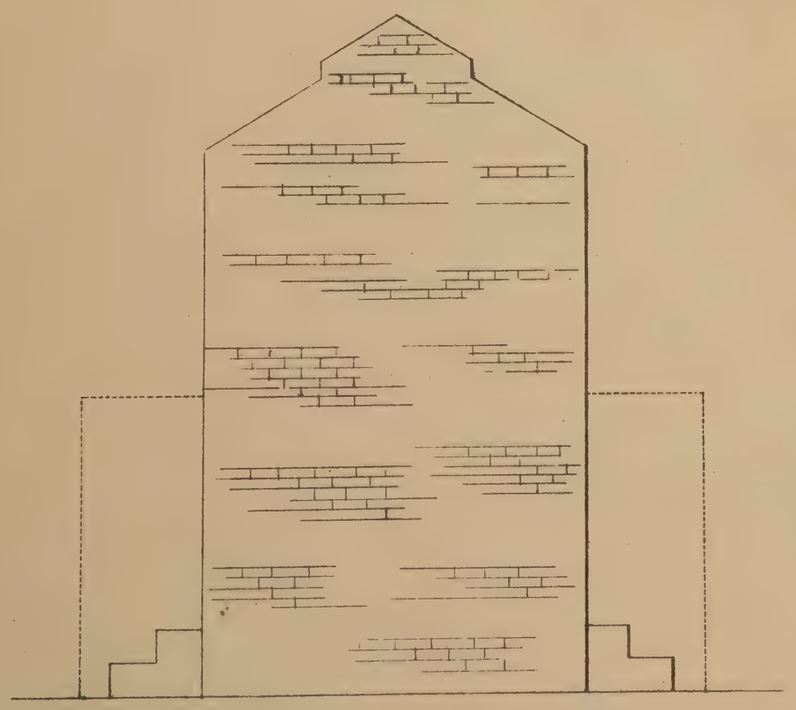
GLASCOW CORPORATION.



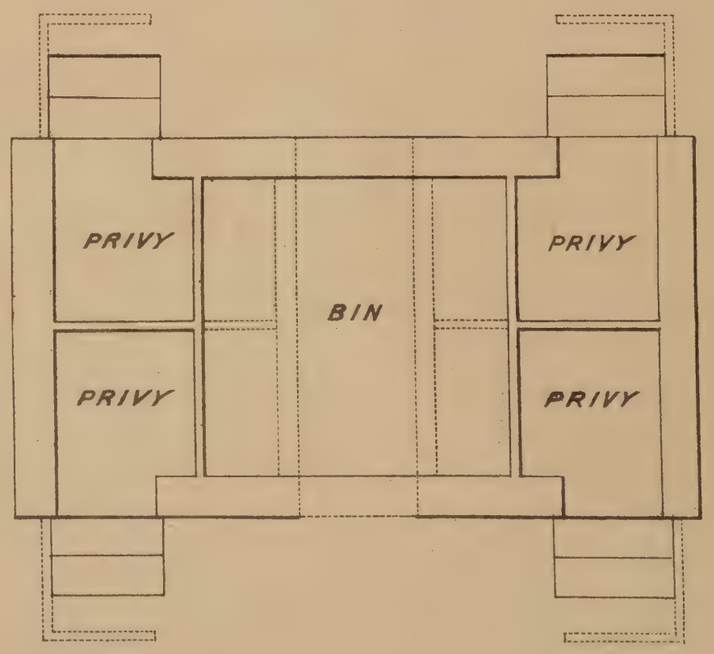
SECTION



ELEVATION



END ELEVATION



PLAN

10 5 0 10

SANITARY. CHAMBERS.

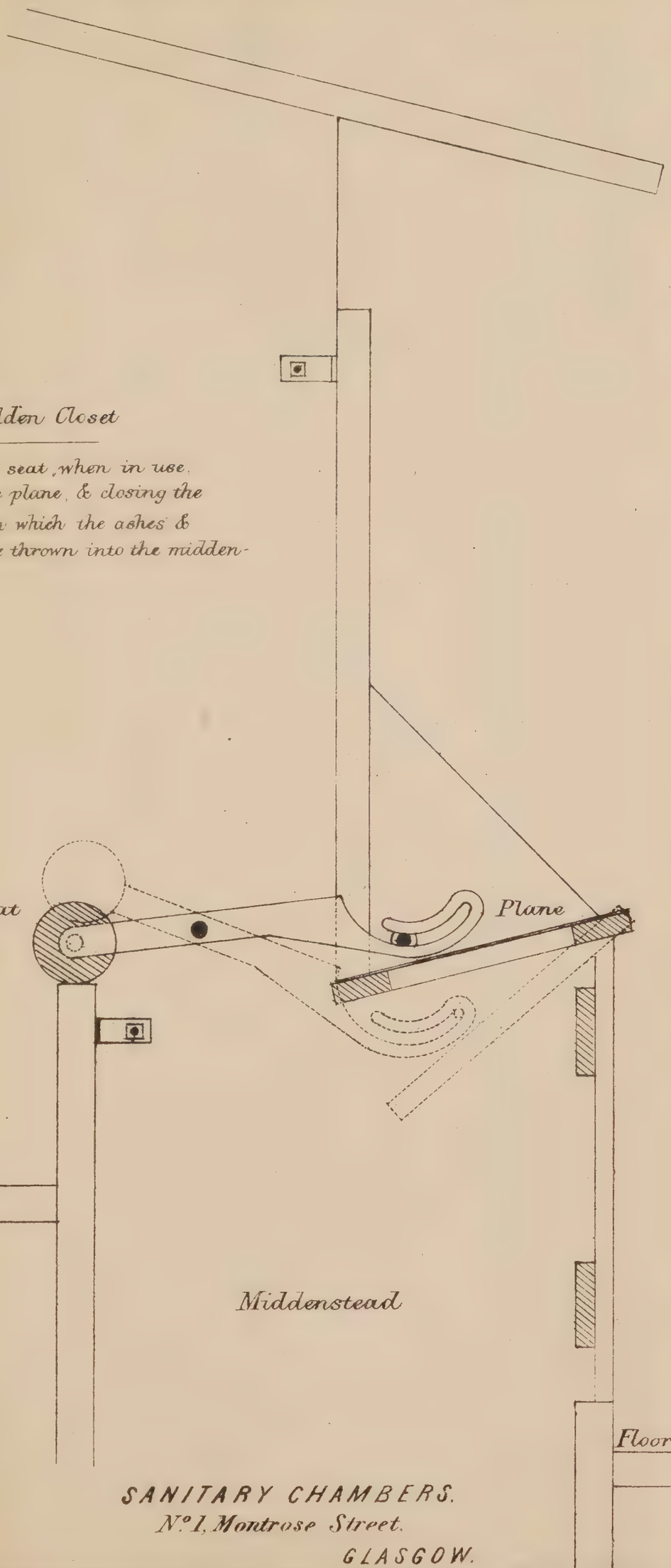
Nº 1 Montrose Street.

GLASGOW.

Dangerfield. Lith. 22, Bedford St. Covent Garden

N.°

GLASGOW CORPORATION



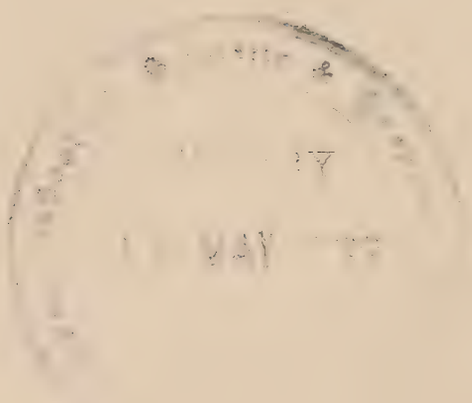
New Midden Closet

Design for the seat, when in use, acting upon the plane, & closing the opening through which the ashes & house-refuse are thrown into the midden-stead.

SCALE ONE INCH = ONE FOOT.

SANITARY CHAMBERS.
N.° 1, Montrose Street.
GLASGOW.

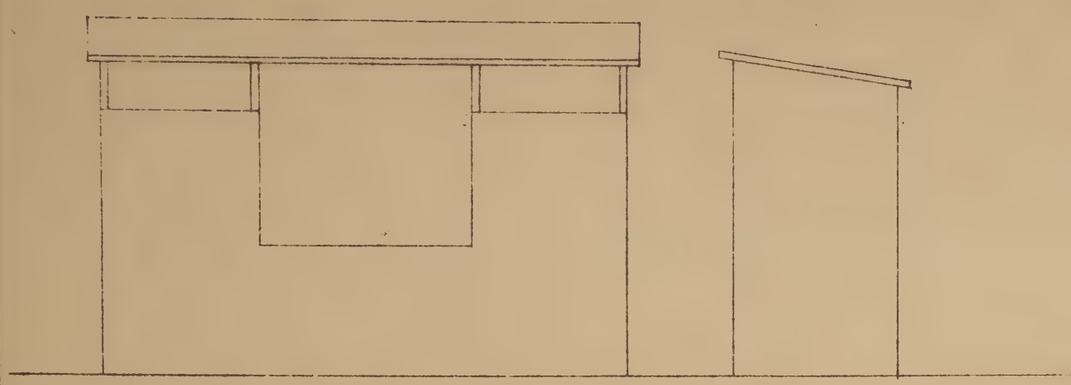
Dangerfield, Lith. London



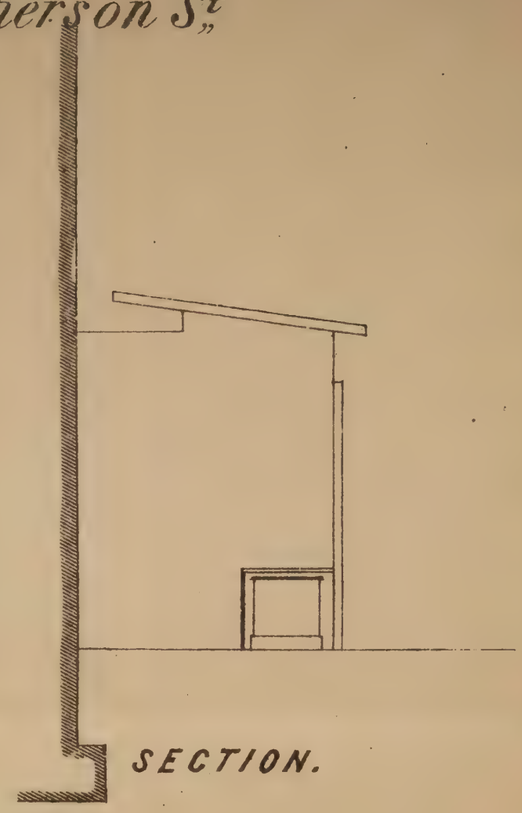
N° 3

GLASGOW CORPORATION.

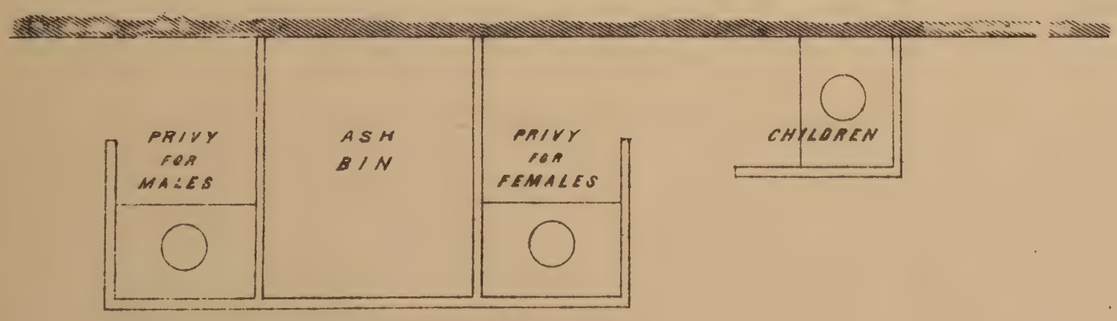
Plan of Privy at N.° 8 Mc Pherson St.



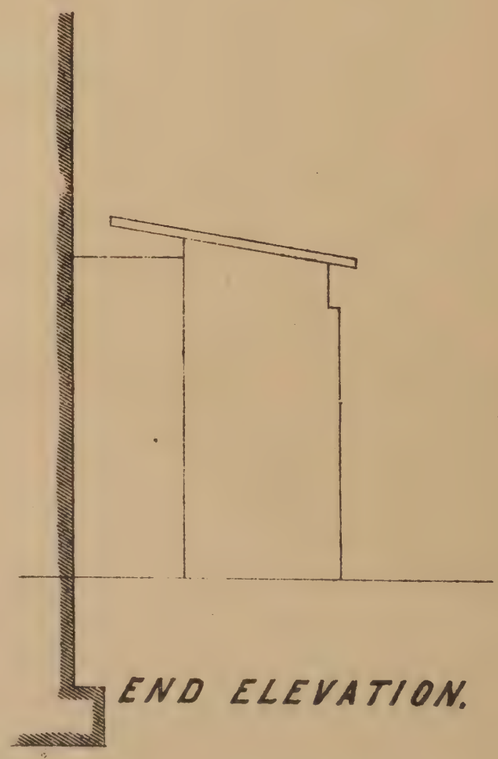
ELEVATION.



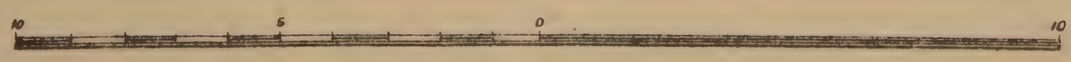
SECTION.



PLAN.



END ELEVATION.



SANITARY CHAMBERS,

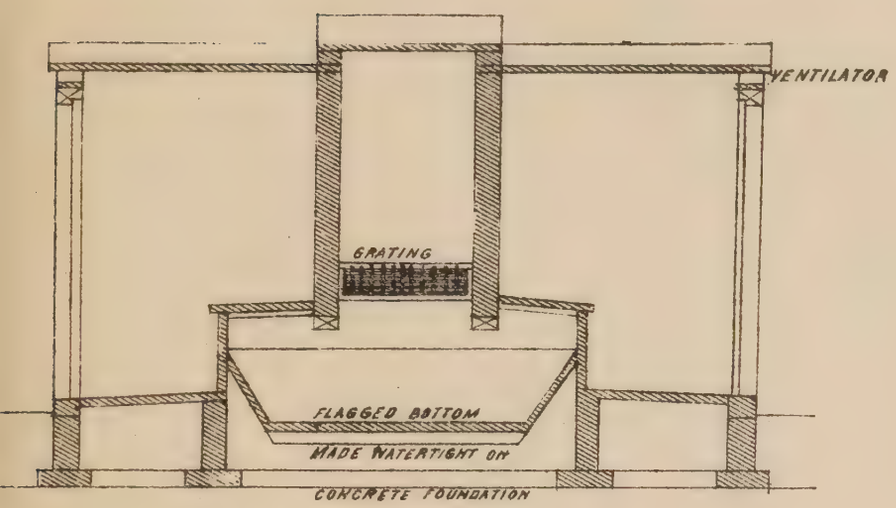
N.° 1, Montrose Street,

GLASGOW.

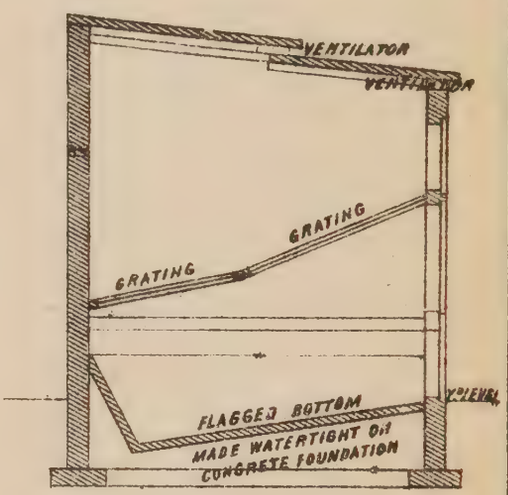
Dangerfield lith. 59 Bedford St. Covent Garden.

BRADFORD CORPORATION.

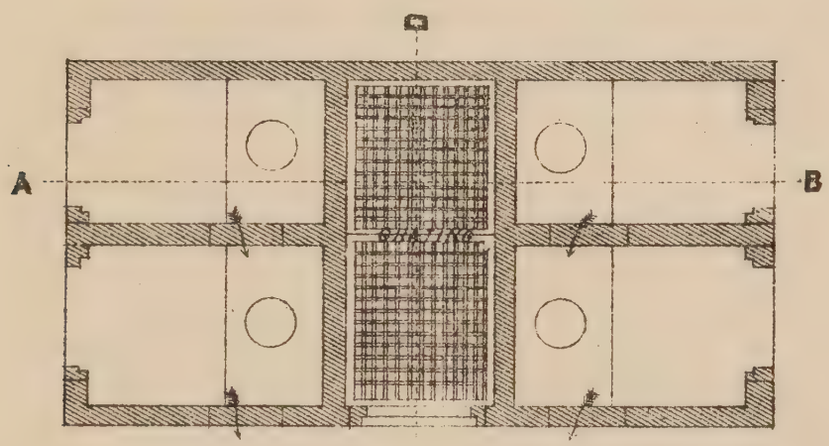
Approved plan of Privies and Ashpit.



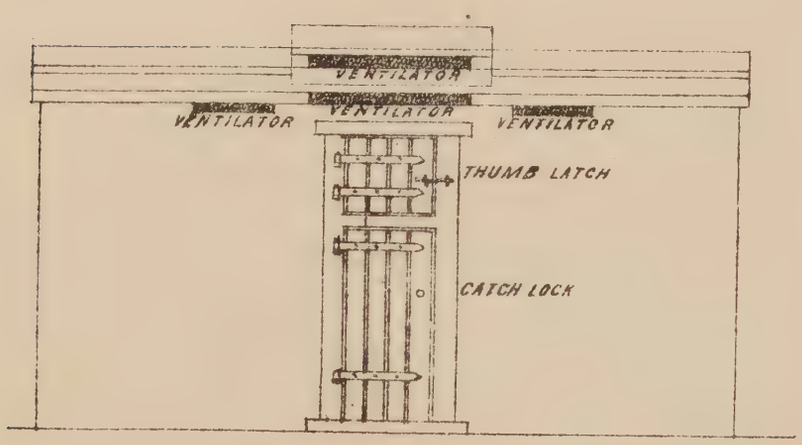
SECTION ON LINE A.B.



SECTION ON LINE C.D.



PLAN

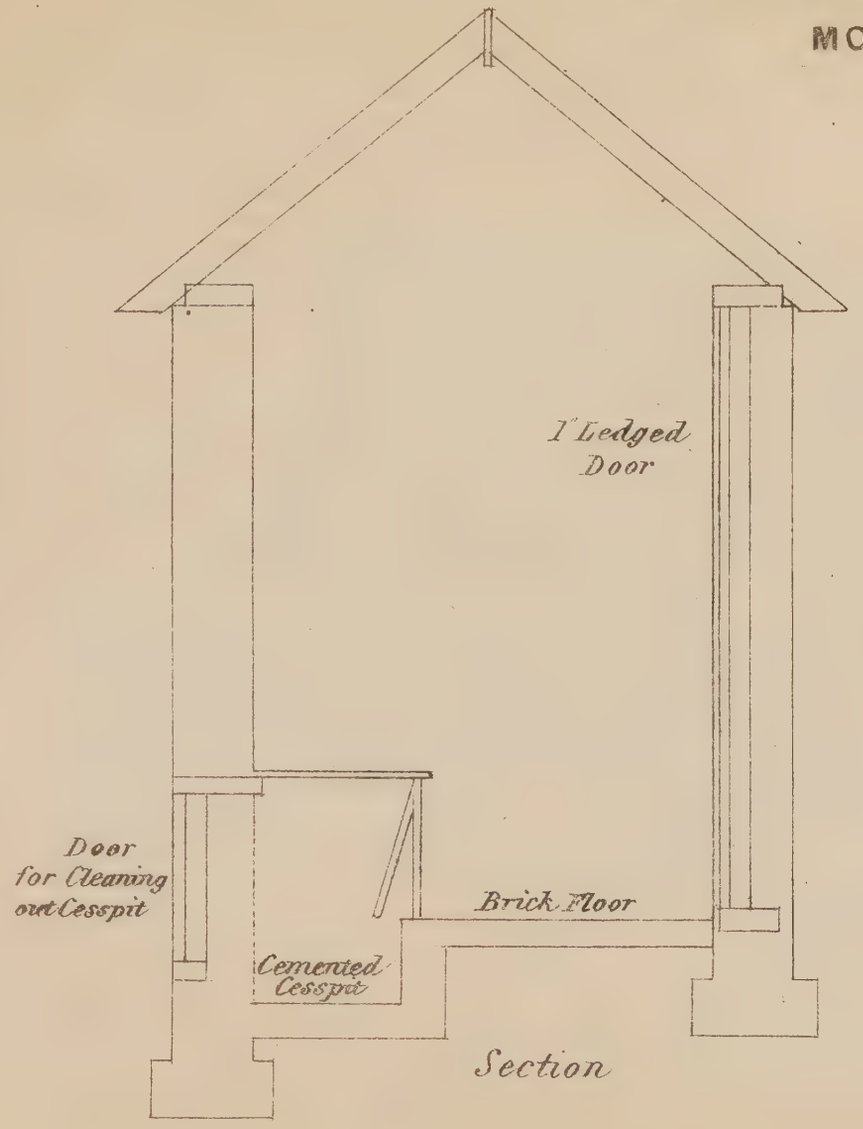


ELEVATION.

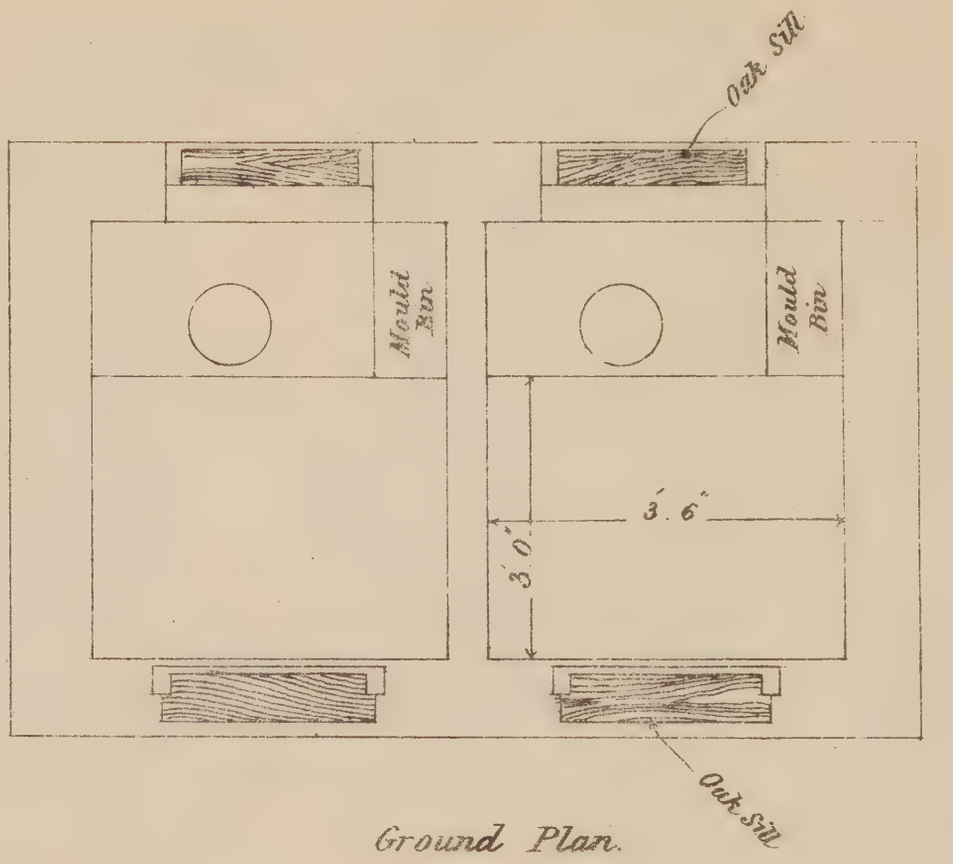
Scale, 1 Inch = 5⅓ Feet.

TRING URBAN SANITARY AUTHORITY.

MODIFIED PRIVIES.



Section



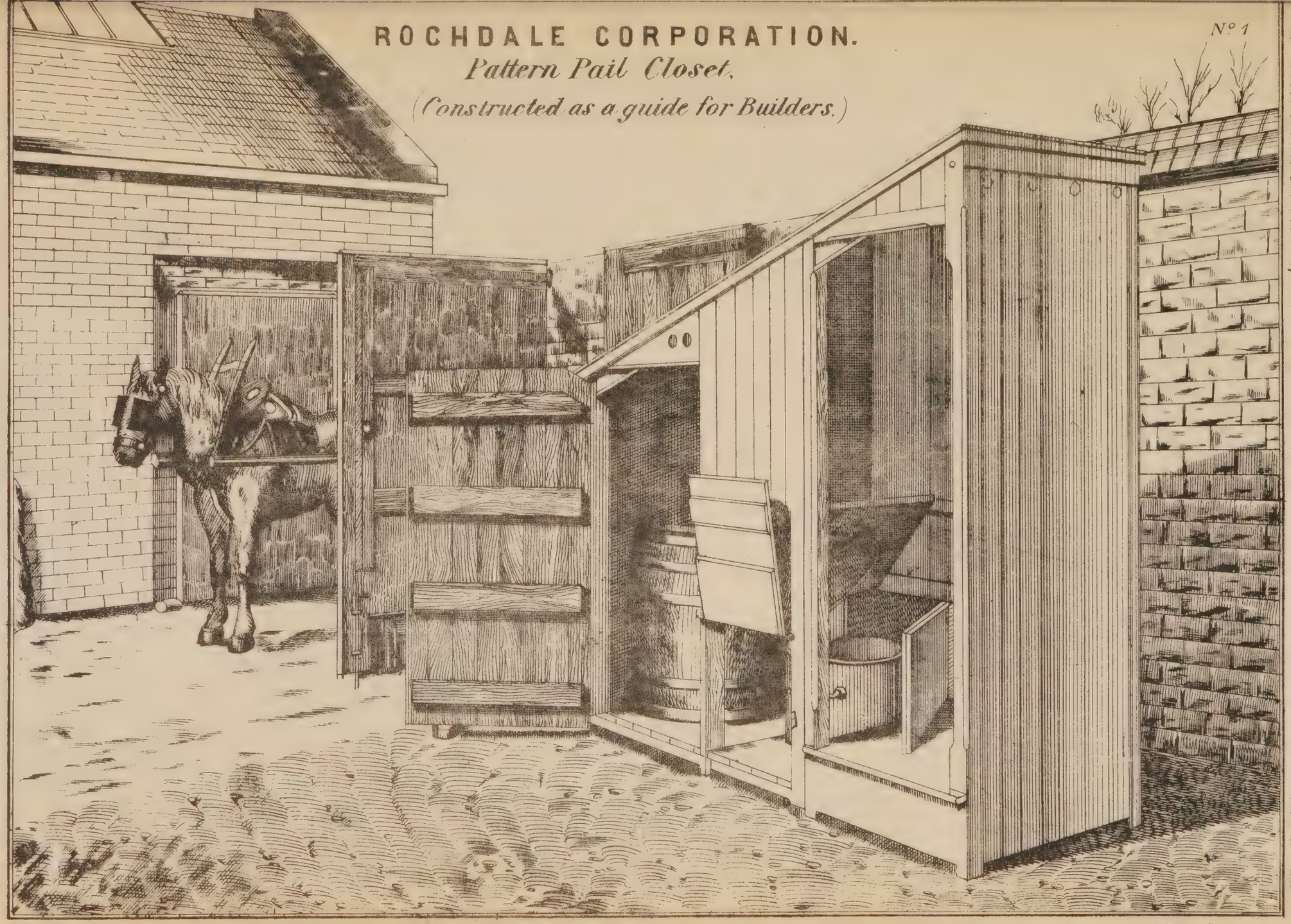
Ground Plan.

SCALE 2 FEET TO 3/4 INCH

ROCHDALE CORPORATION.

Pattern Pail Closet.

(Constructed as a guide for Builders.)

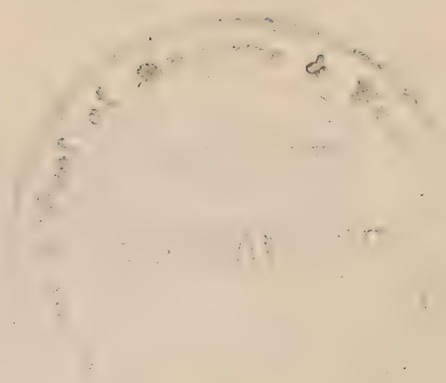


Nº 1

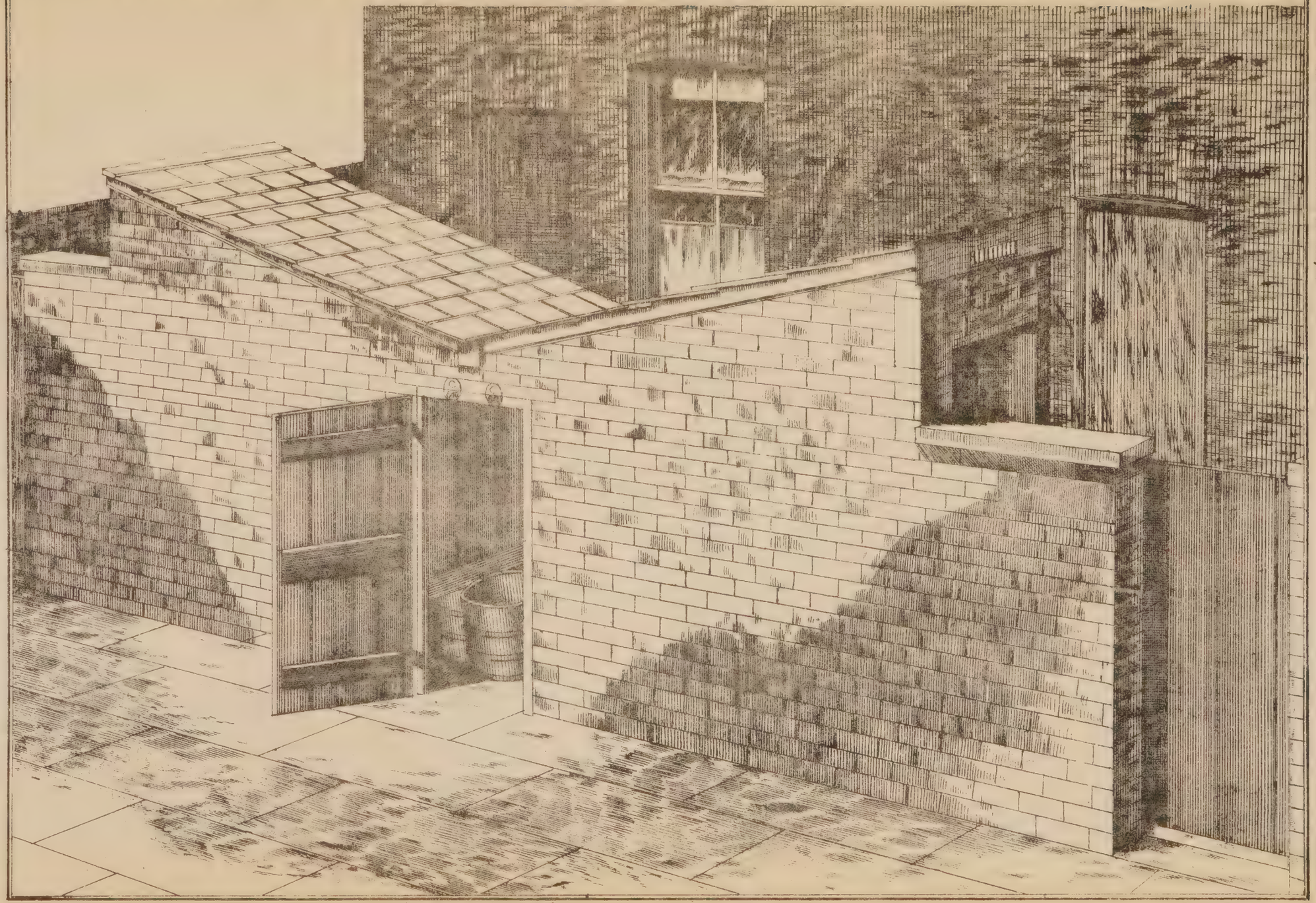
Mr Netten Radcliffe's Report.

PLATE X.

Dangerfield, Lith. London



ROCHDALE CORPORATION. *Pail Closets as Erected on New Property.* No. 2.



Dangerfield, Lith. London

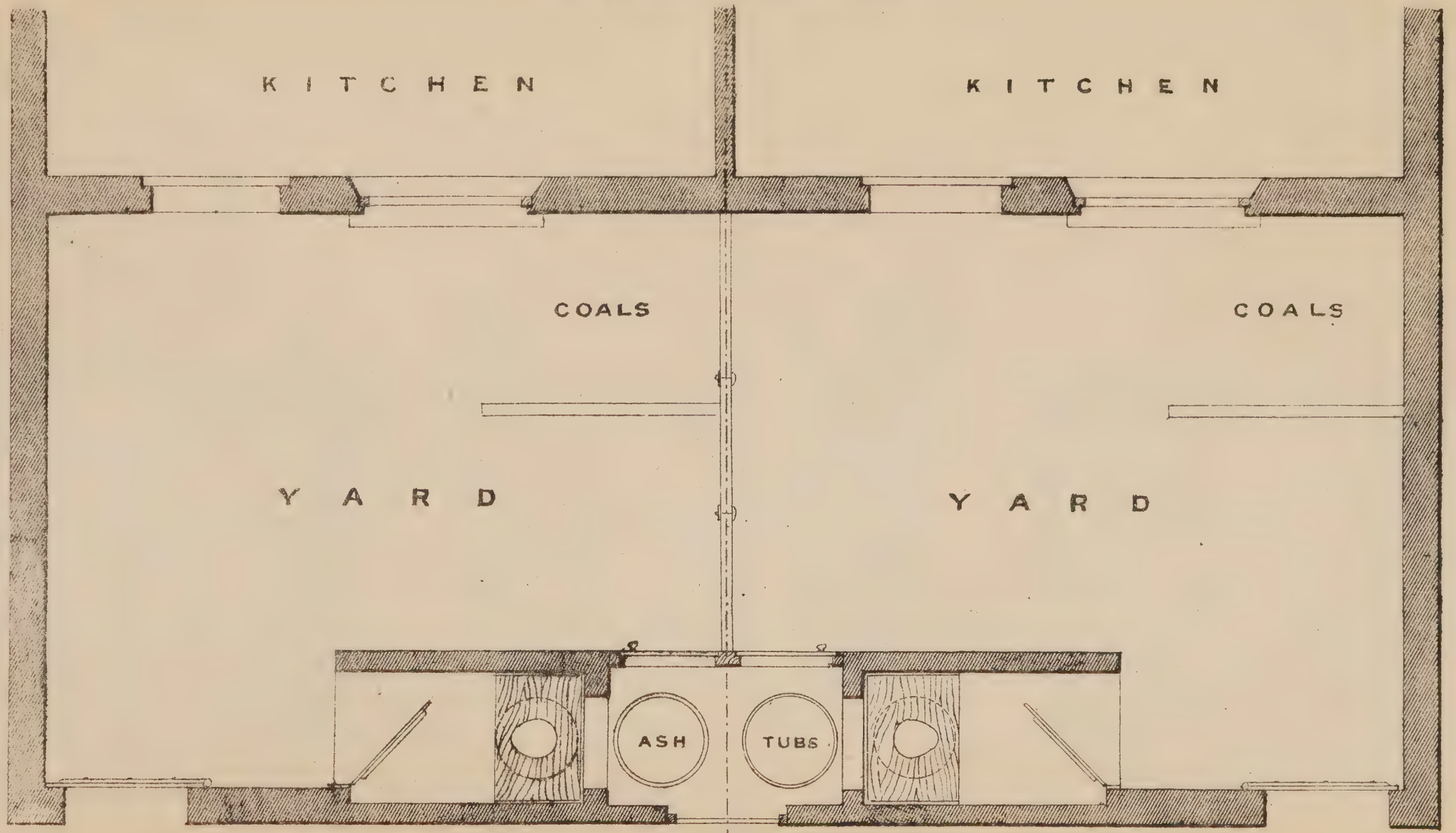
Mr Netten Radcliffe's Report

PLATE XI.

(3) ROCHDALE CORPORATION.

No 3.

GROUND PLAN OF BACK PREMISES OF TWO DWELLING HOUSES SHOWING ARRANGEMENT. OF PRIVIES AND ASHPLACE.



Scale 4 Ft=1 Inch.

Dangerfield Lith. London.

ROCHDALE CORPORATION.

Excrement Pail with lid on, full, to return to Works. *Ash Tub (Empty)* *Excrement Pail empty ready for use*

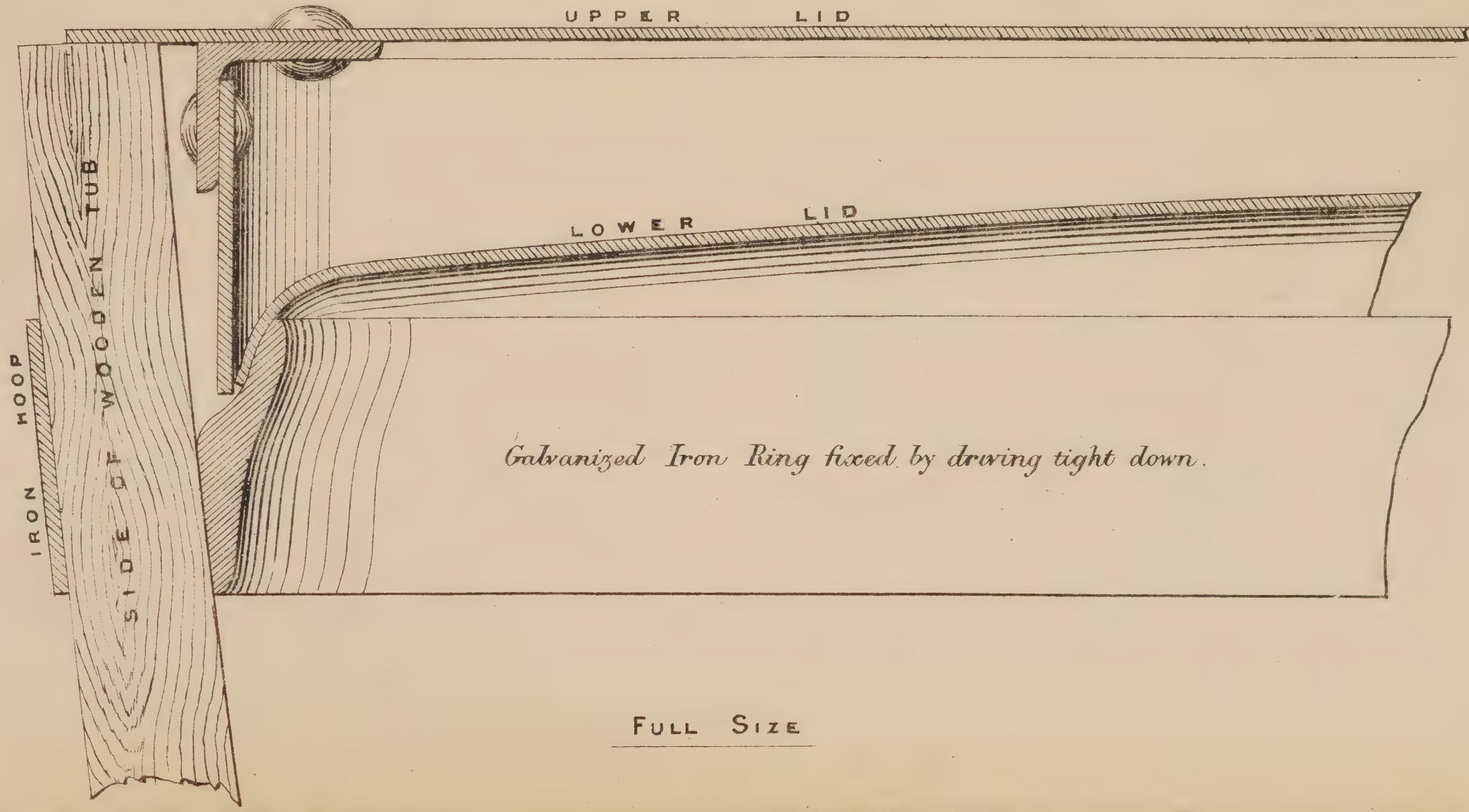
Excrement Pail; Diameter, mouth 19½ in, bottom 16½ in; Height 15½ in. Ash Tub: Diameter, mouth 23½ in, bottom 20½ in; Height 15½ in.

Mr Netten Radcliffe's Report

PLATE XIII.

Dangerfield, Lith. London

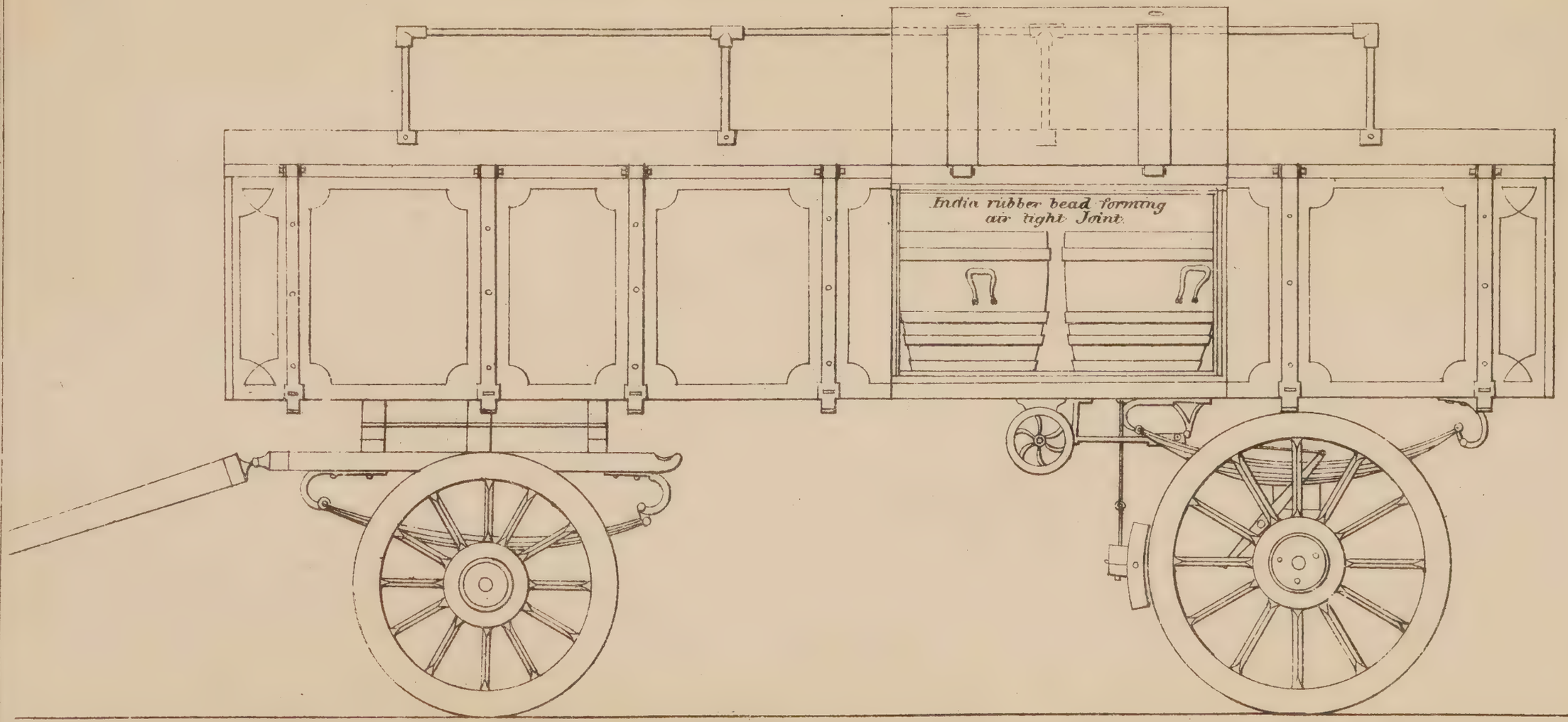
ROCHDALE CORPORATION.—SECTION THROUGH SIDE OF EXCREMENT PAIL.



FULL SIZE

ROCHDALE CORPORATION. COLLECTING VAN

SIDE ELEVATION.



Scale 1 inch = 4 feet.

Mr Netten Radcliffe's Report.

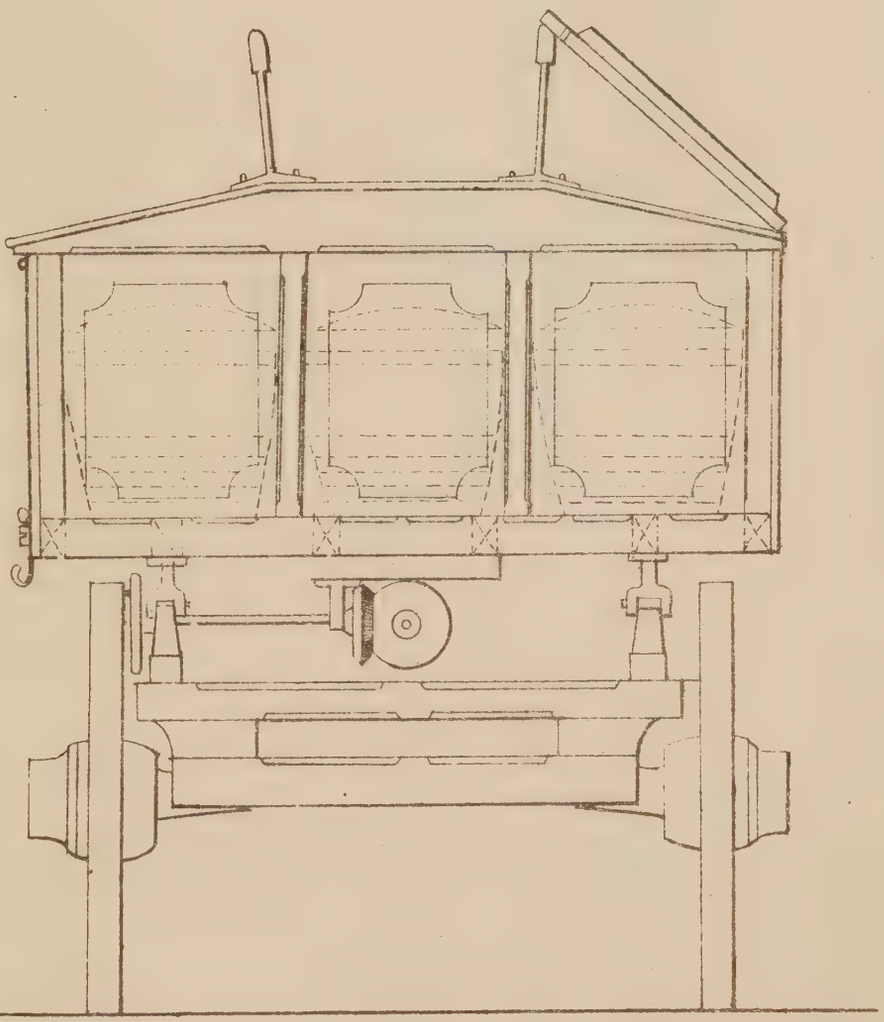
PLATE XV.

No. 6.

N° 7

ROCHDALE CORPORATION. COLLECTING VAN

END ELEVATION
OF
COLLECTING VAN.

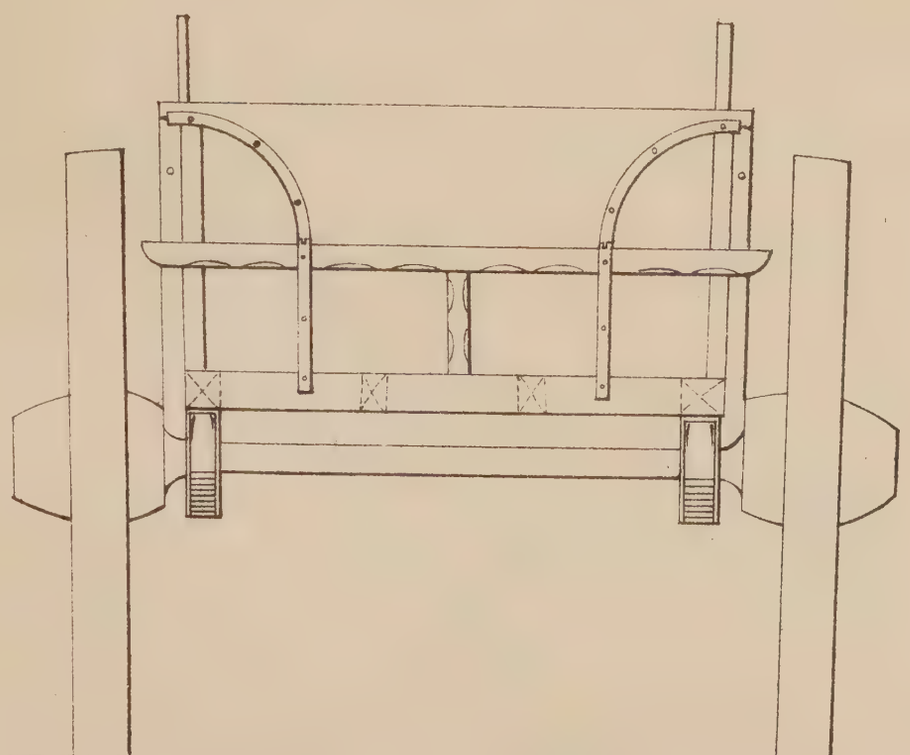


Scale 1 inch = 4 feet.

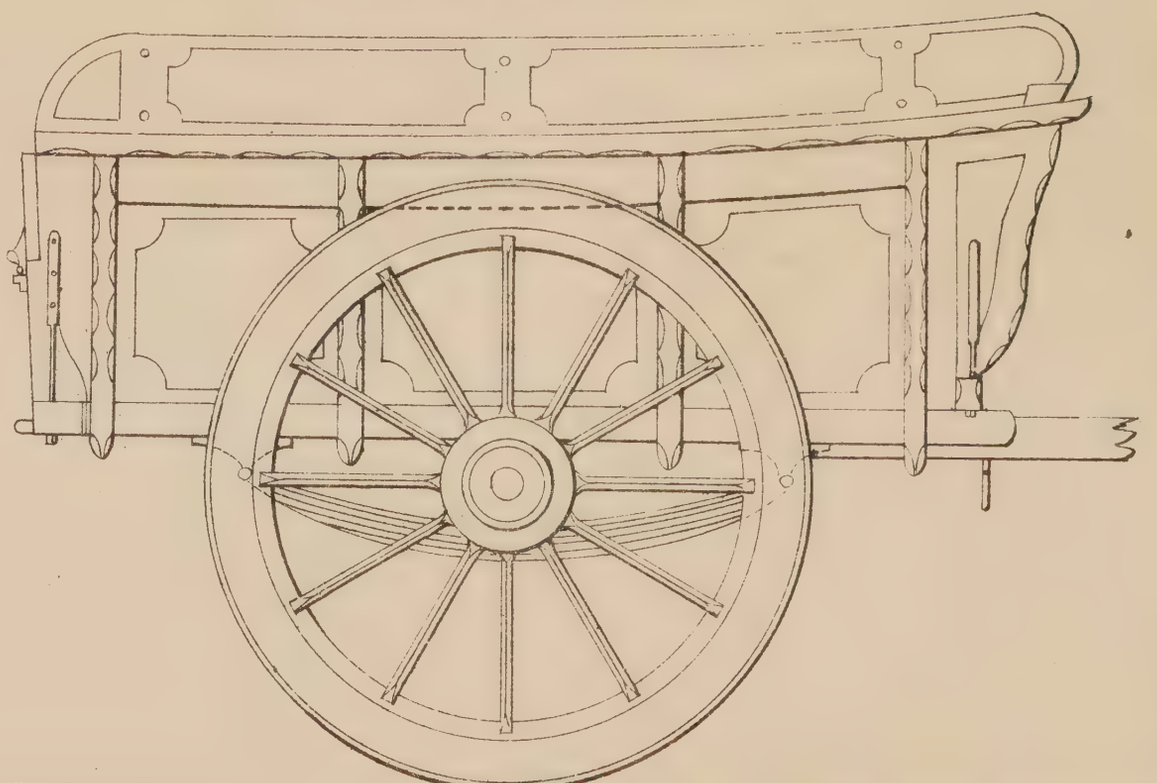
Dangerfield, Lith. London

ROCHDALE CORPORATION. DUST CART.

BACK ELEVATION.



SIDE ELEVATION.



Scale, 1 inch = 4 feet.

W. Netten Radcliffe's Report.

PLATE XVII.

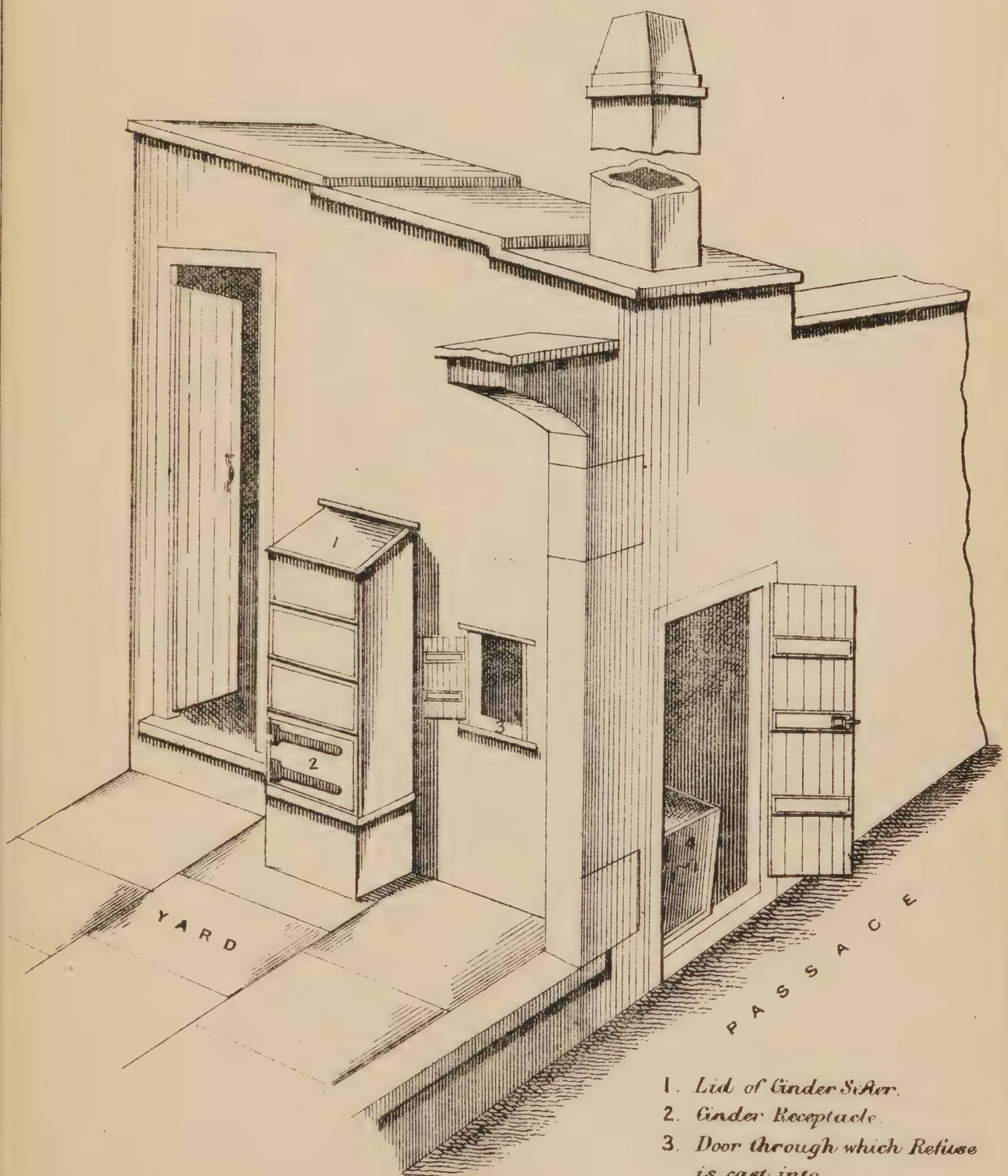
No. 8.

Dangerfield, Lith. London.

N.o 1.

MANCHESTER CORPORATION.

DRY ASH CLOSET. ELEVATION.



1. *Lid of Cinder Sifter.*
2. *Cinder Receptacle.*
3. *Door through which Refuse is cast into*
4. *Pail for dry House Refuse.*

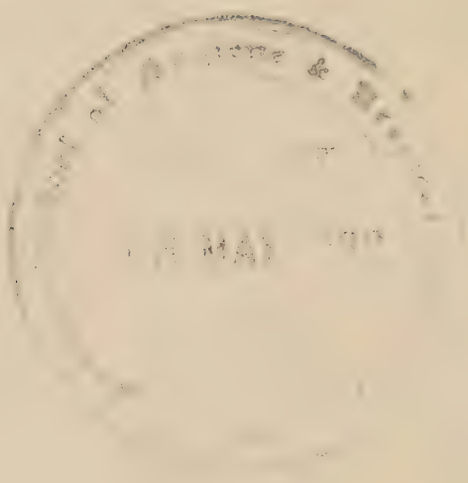
...rfield, Lith. London

N° 2.

MANCHESTER CORPORATION.

DRY ASH CLOSET.—SECTION.

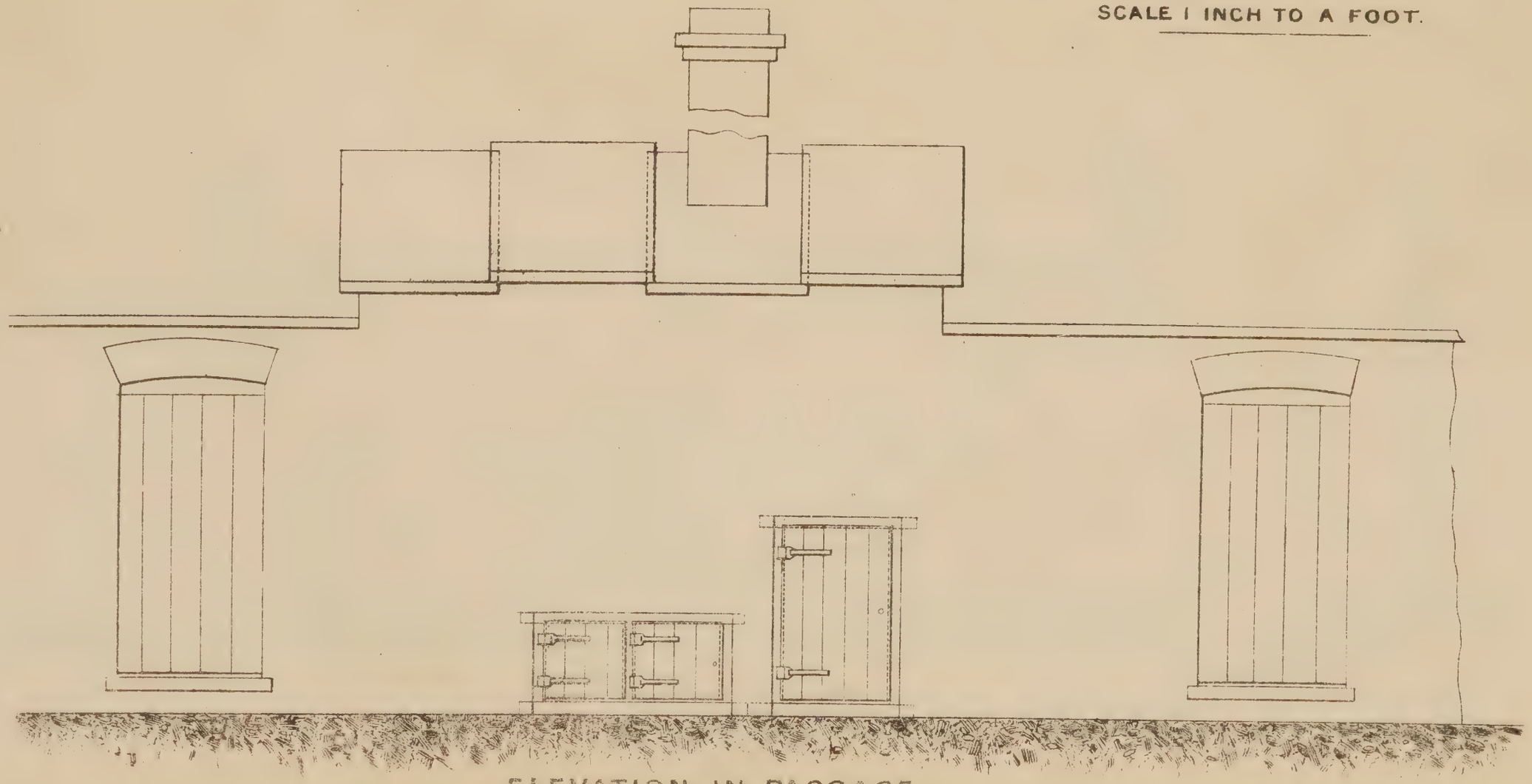
1. *Excrement Pail.*



CITY OF MANCHESTER.

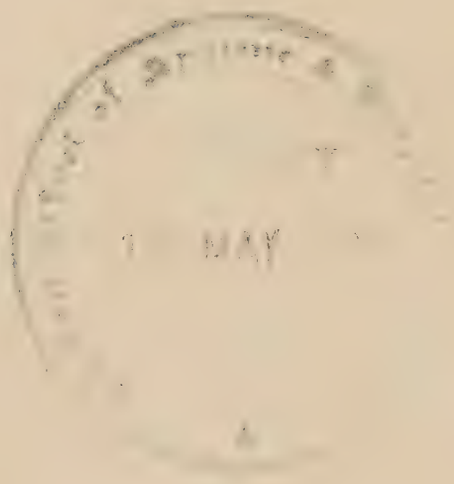
DETAIL DRAWING ATTACHED TO SPECIFICATION OF PRIVIES.

SCALE 1 INCH TO A FOOT.



ELEVATION IN PASSAGE

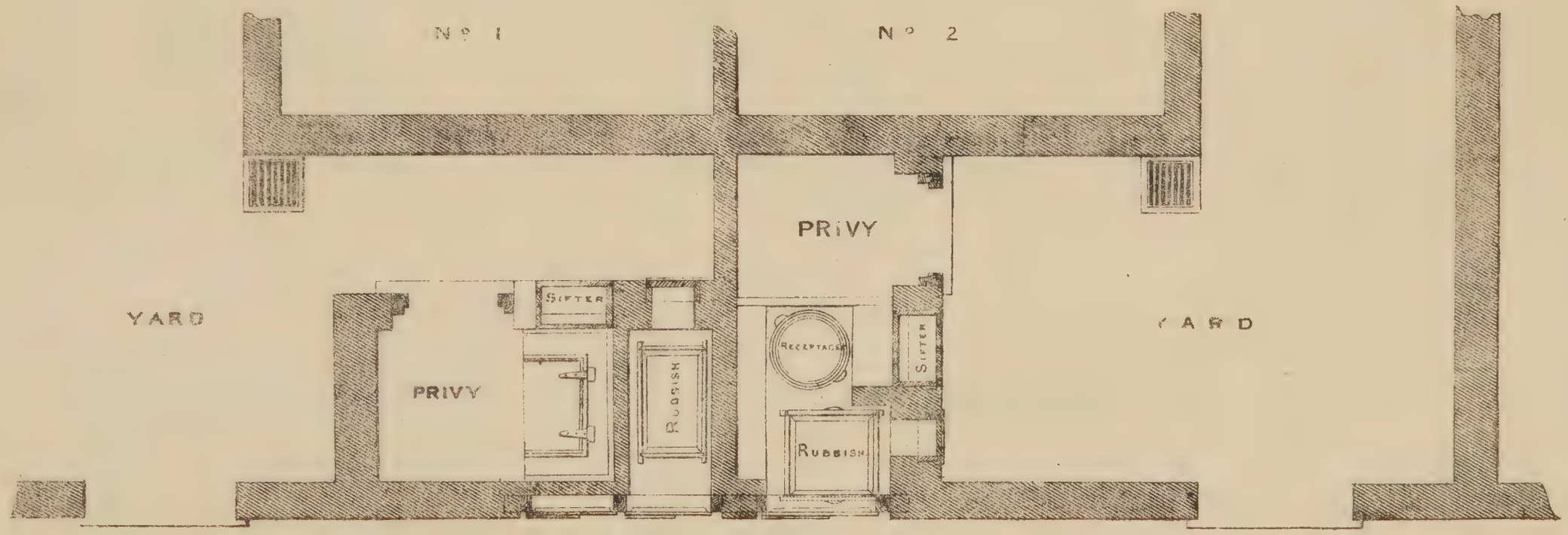
Dangerfield Lith London



CITY OF MANCHESTER

DETAIL DRAWING ATTACHED TO SPECIFICATION OF PRIVIES.

SCALE 1 INCH TO A FOOT.



GENERAL PLAN

W. Netten Radcliffe's Report

PLATE XXI.

No 4.

Dangerfield, Lith.

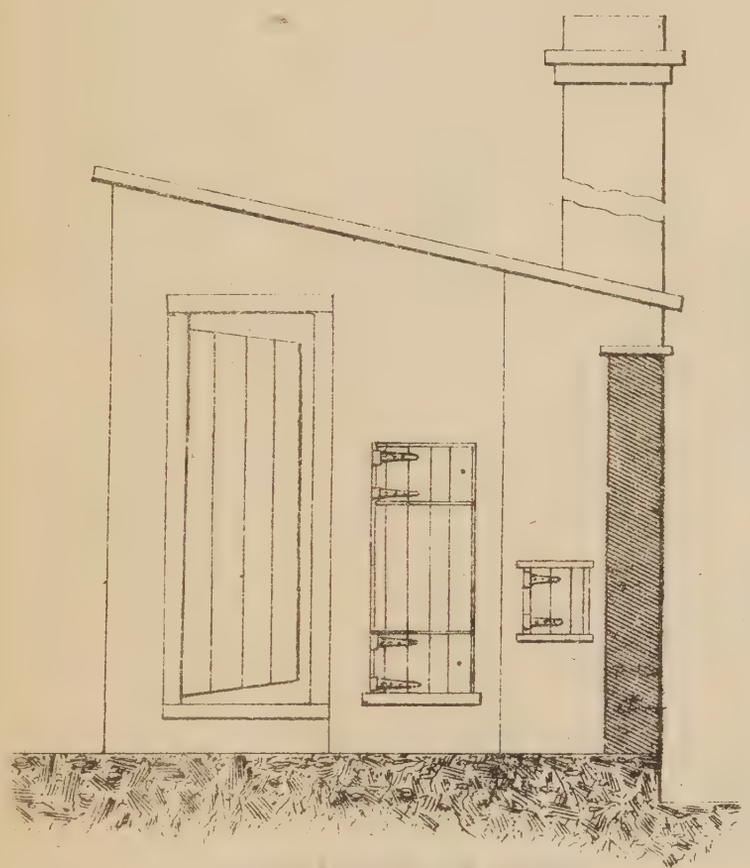
No 5.

CITY OF MANCHESTER.

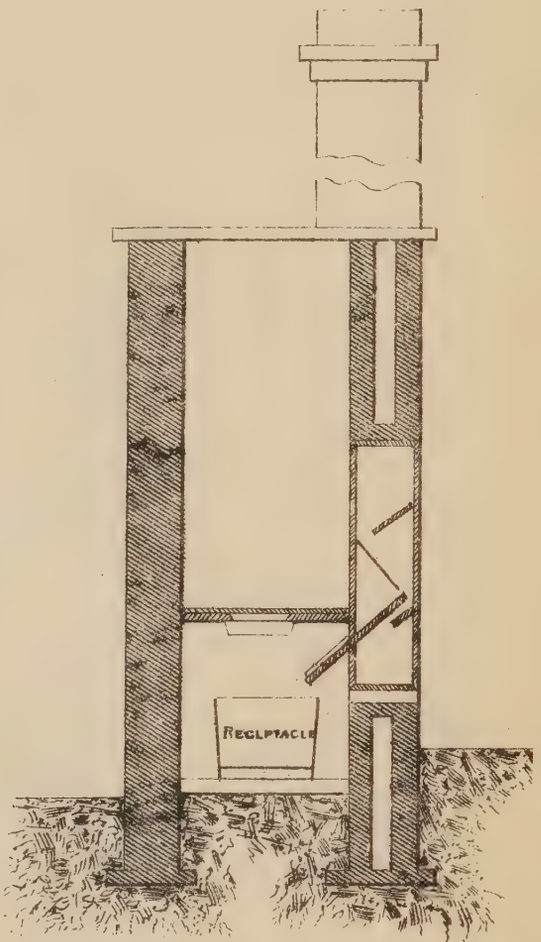
DETAIL DRAWING ATTACHED TO SPECIFICATION OF PRIVIES.

SCALE 1 INCH TO A FOOT.

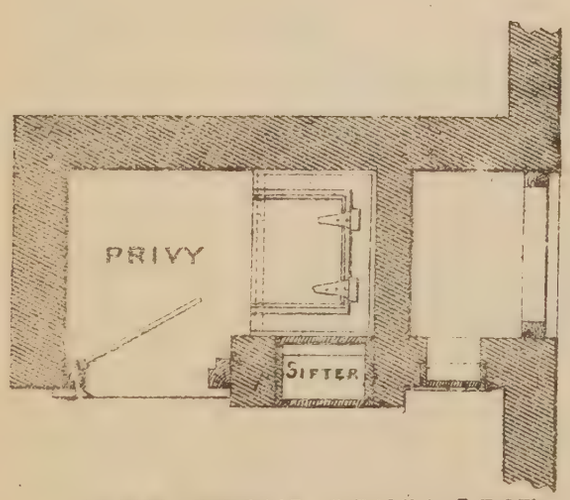
DETAILS OF Nº 2



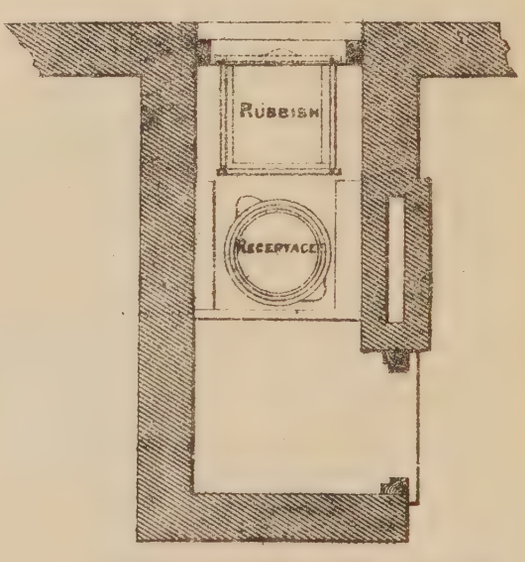
ELEVATION IN YARD



SECTIONAL ELEVATION



PLAN ABOVE PRIVY SEAT



PLAN OF PRIVY FLOOR

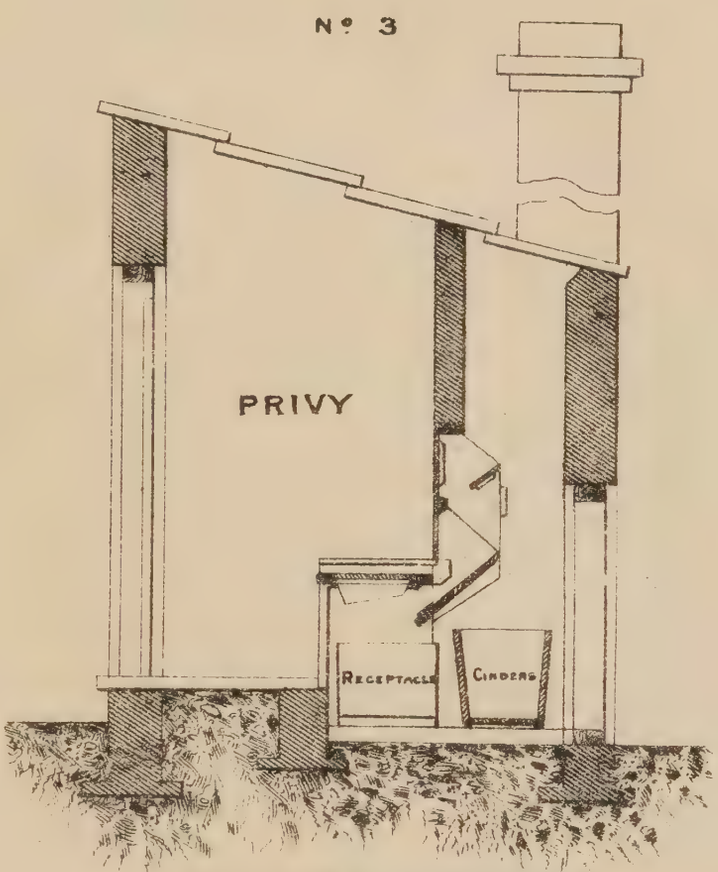
Bousfield & Co. Lith. London.

No. 6.

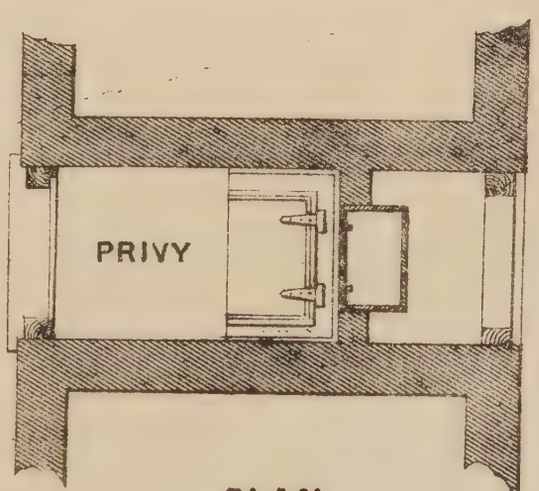
CITY OF MANCHESTER.

DETAIL DRAWING ATTACHED TO SPECIFICATION OF PRIVIES.

SCALE 1 INCH TO A FOOT.

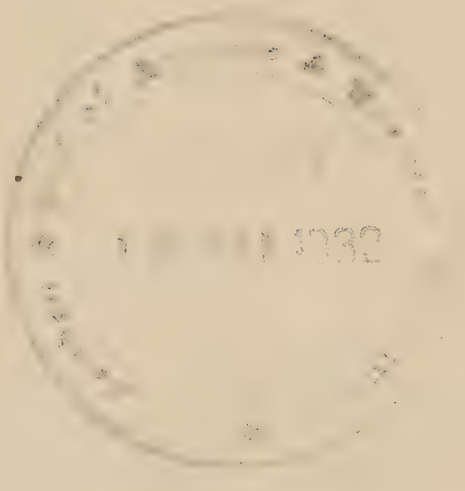


SECTIONAL ELEVATION



PLAN

Dangerfield Lith. London

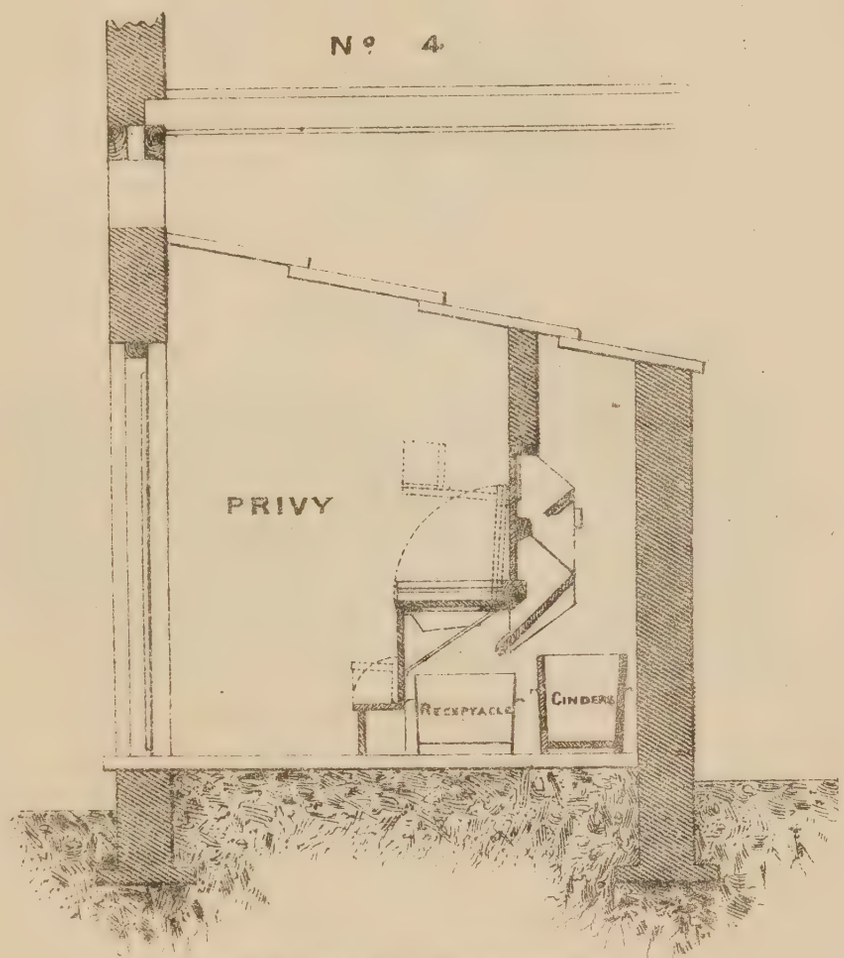


N.o 7.

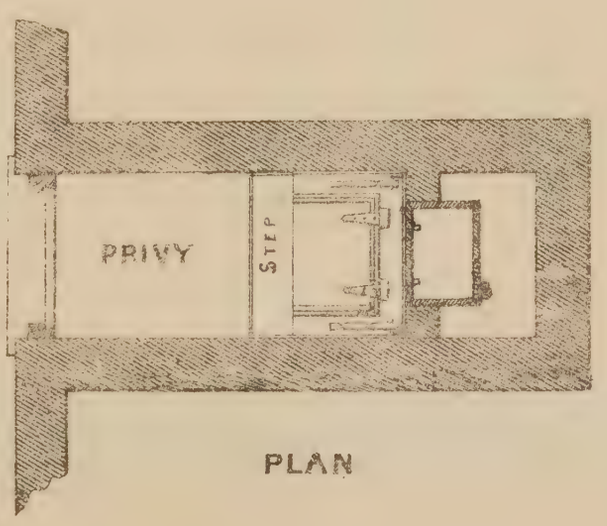
CITY OF MANCHESTER

DETAIL DRAWING ATTACHED TO SPECIFICATION OF PRIVIES.

SCALE 1 INCH TO A FOOT.



SECTONAL ELEVATION.



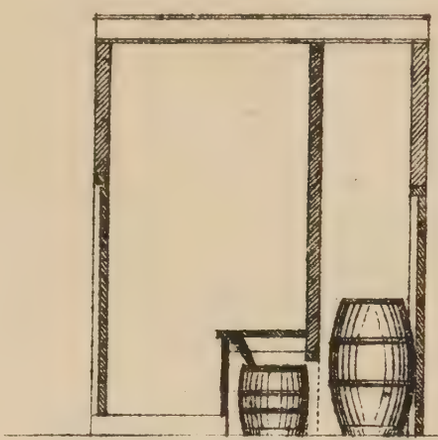
PLAN

Dangerfield, Lith Londo.

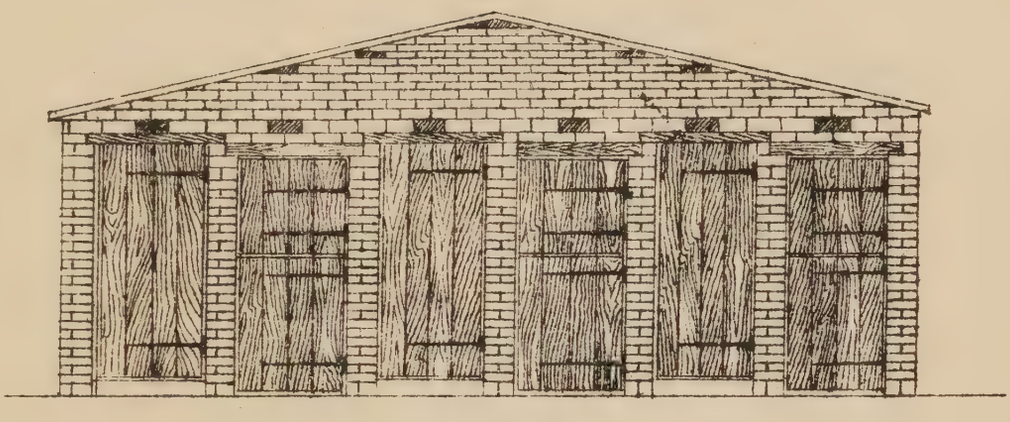
HALIFAX CORPORATION.

Nº 1.

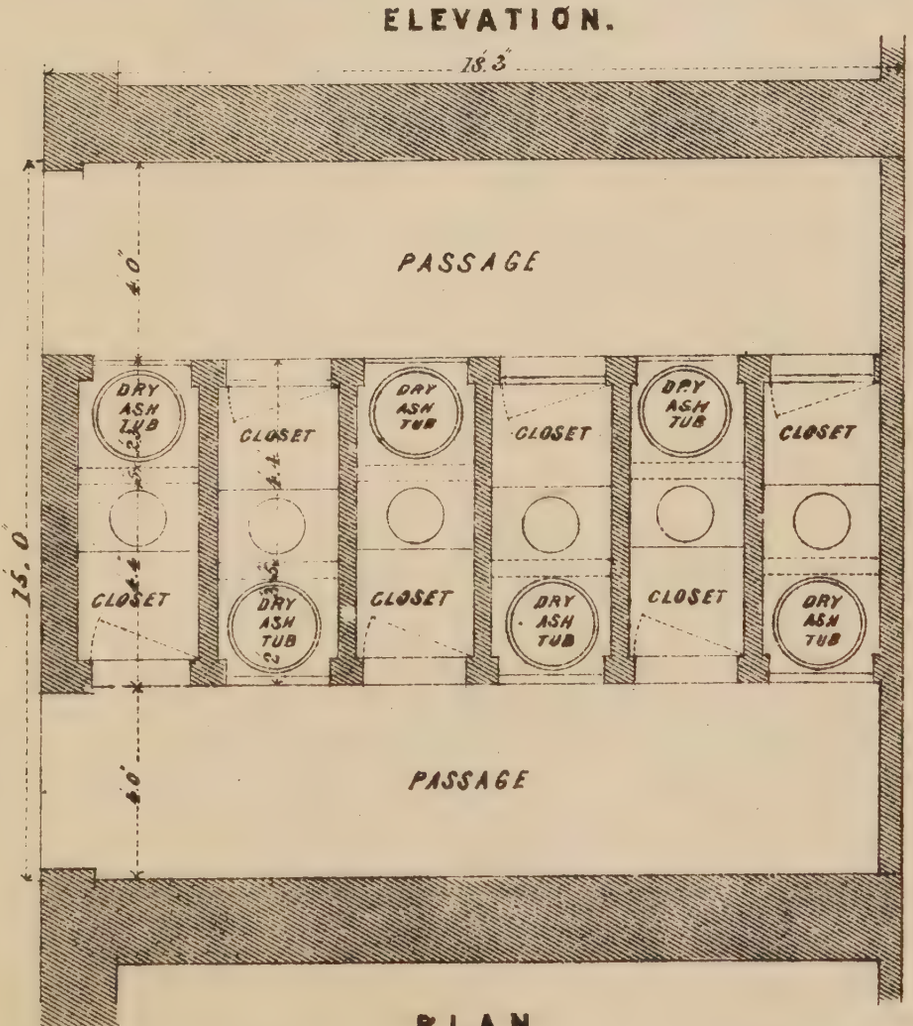
Plan of Gouse's Closets accompanying specification of Works.—
Nº 1. Suitable for existing back to back Houses.



SECTION.



ELEVATION.

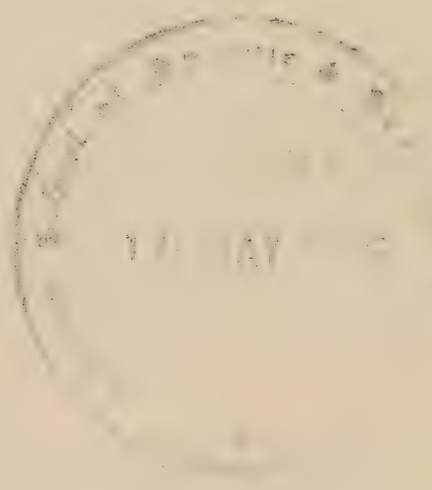


PLAN.

SCALE, 1 INCH EQUAL TO 6 FEET.

BOROUGH ENGINEER'S OFFICE
TOWN HALL, HALIFAX.
JUNE, 30TH 1871.

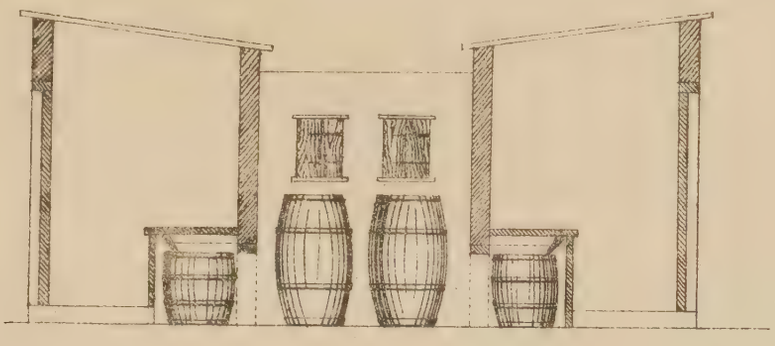
Dangerfield Lith. London



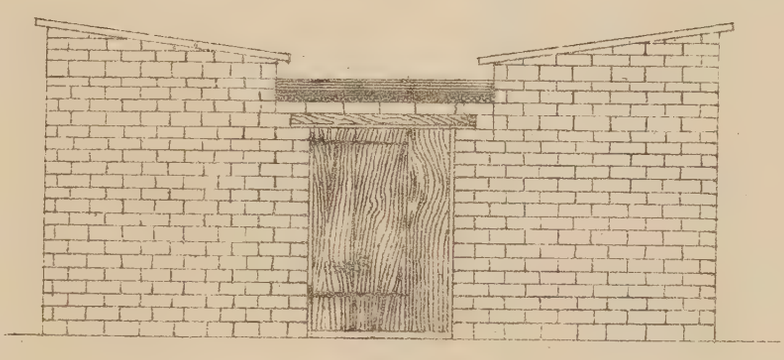
N.º 3.

HALIFAX CORPORATION.

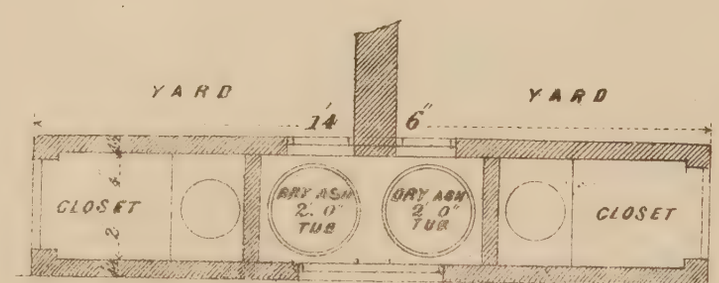
Plan of Goux's Closets accompanying specification of works.—
N.º 2, Suitable for separate Dwellings with Yards.



SECTION



ELEVATION.



PLAN.

SCALE 1 INCH EQUAL TO 6 FEET.

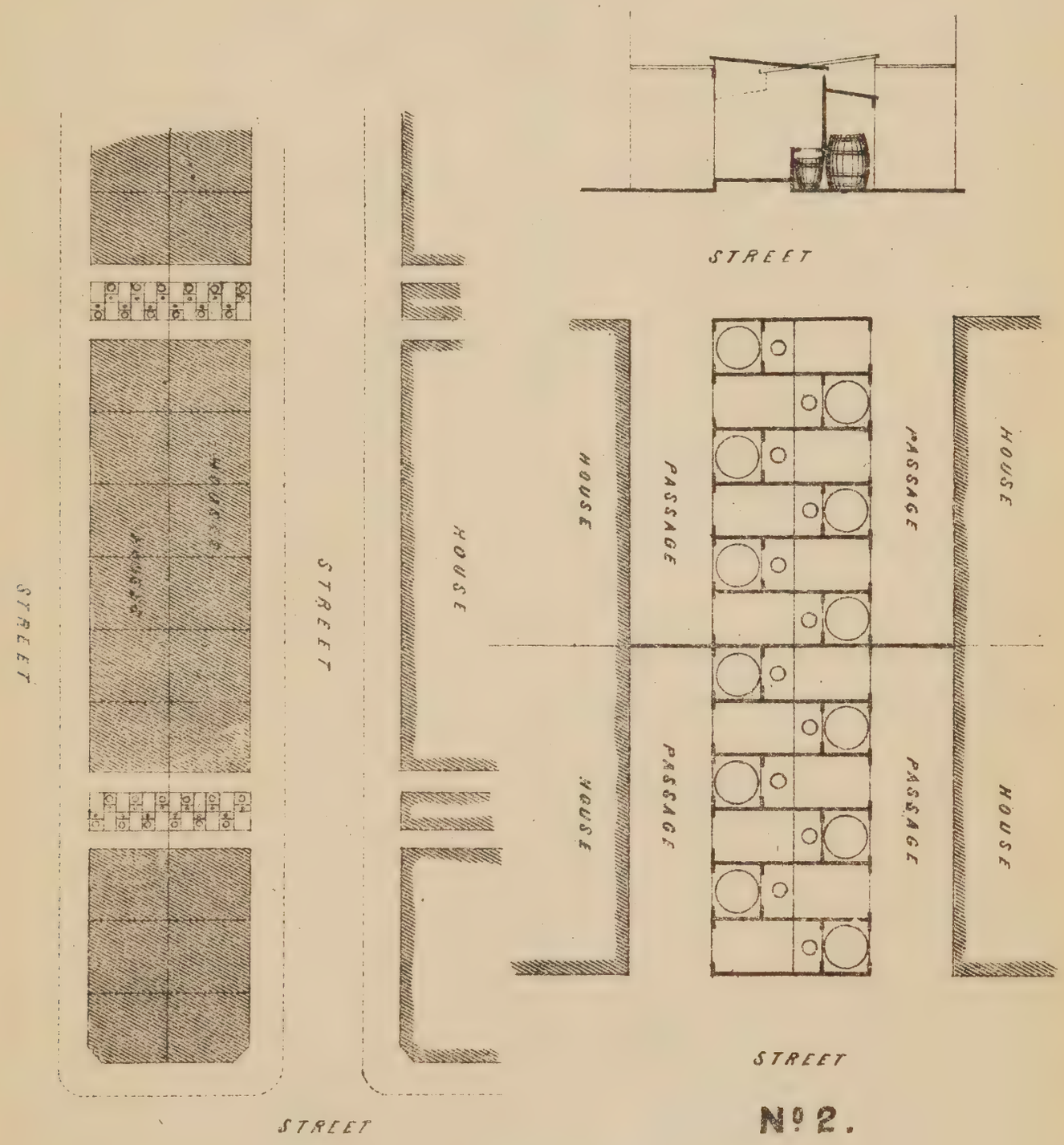
BOROUGH ENGINEER'S OFFICE,
TOWN HALL, HALIFAX,
JUNE 30TH 1871.

Dangerfield Lith.

N° 3.

HALIFAX CORPORATION.

Plans shewing various arrangements of Goux's Closets.



N° 1.

N° 2.

24 Feet = 1 Inch.

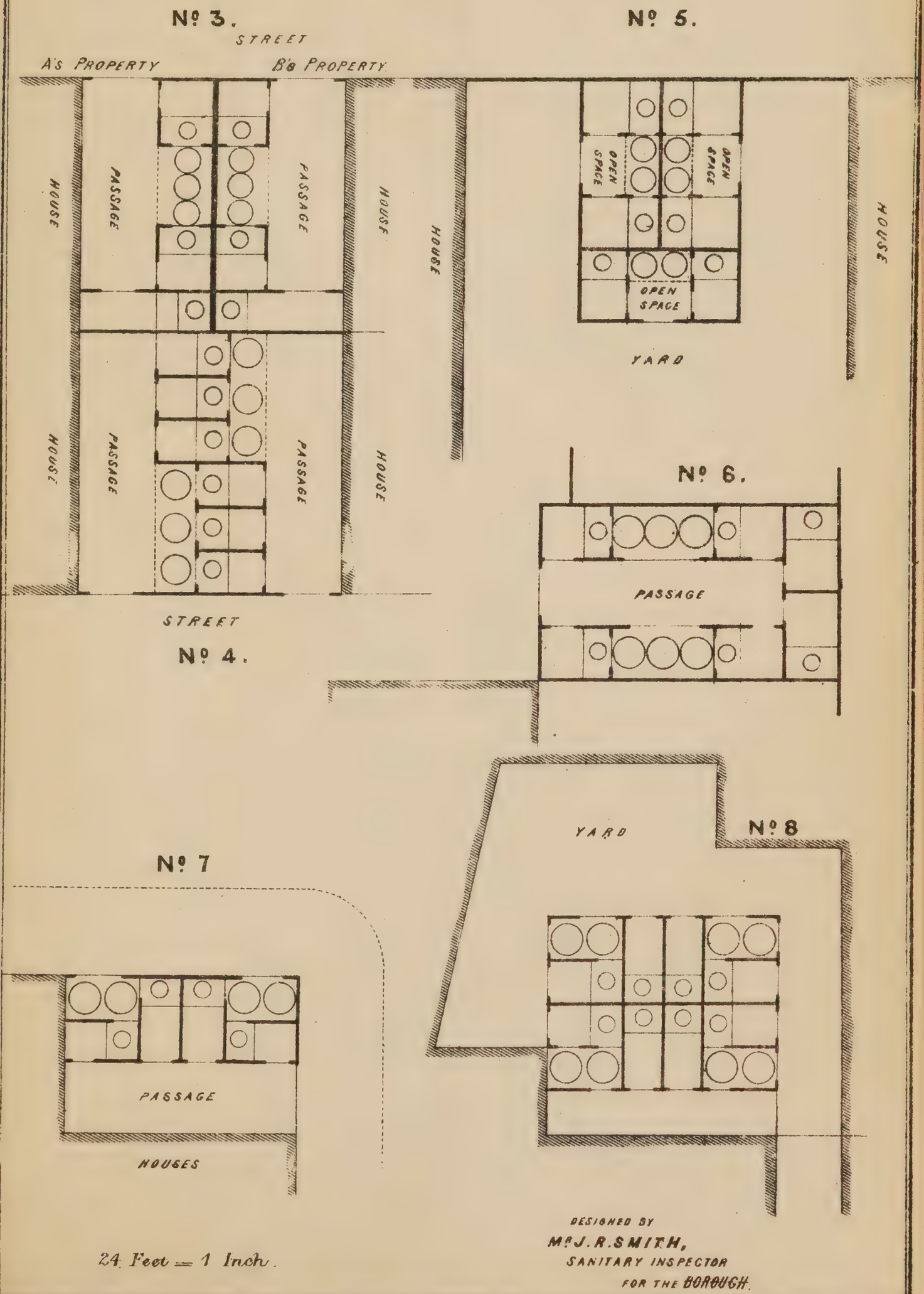
DESIGNED BY
Mr J. R SMITH,
SANITARY INSPECTOR,
FOR THE BOROUGH.

Dangerfield Lith London

No 1

HALIFAX CORPORATION.

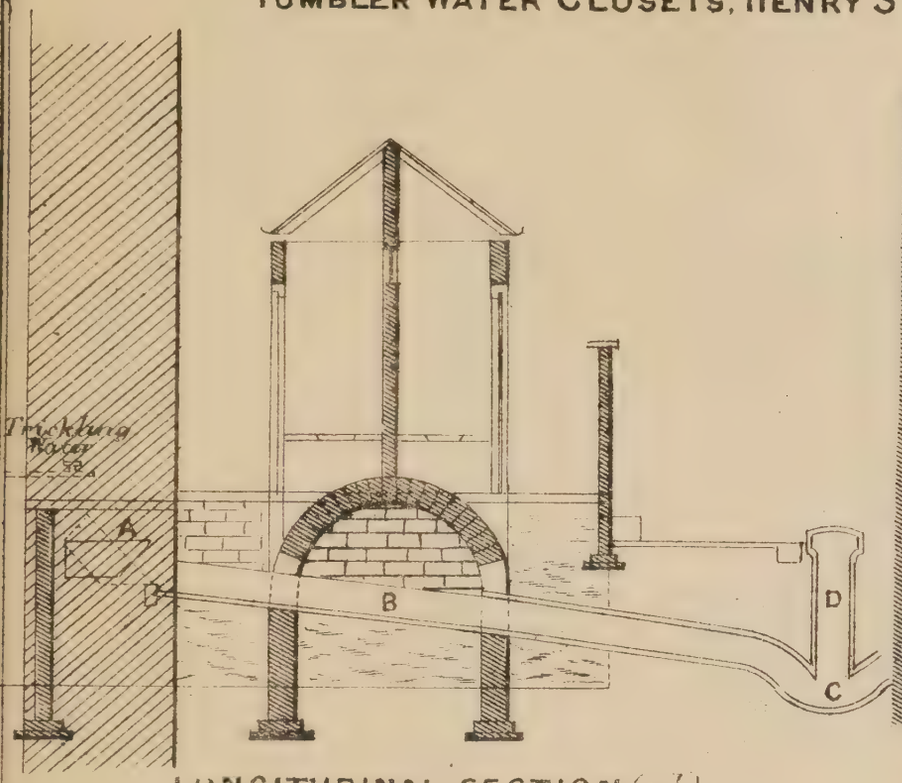
Plan shewing various arrangements of Goux's Closets.



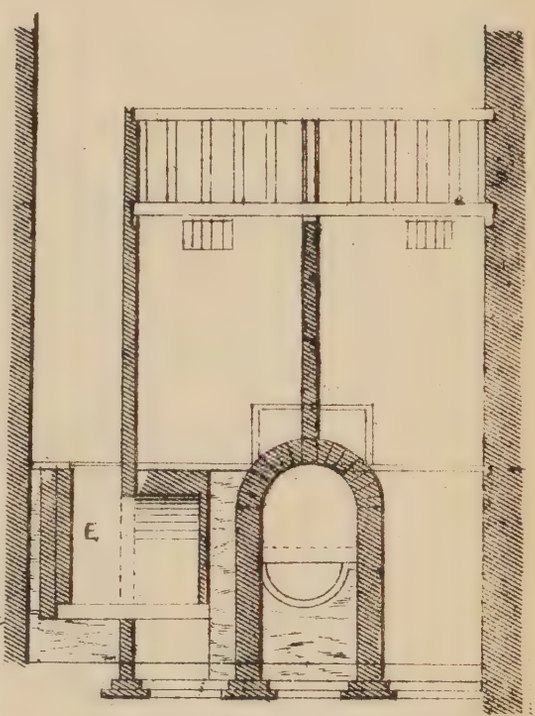
Dangerfield, Lith. London

LEEDS CORPORATION.

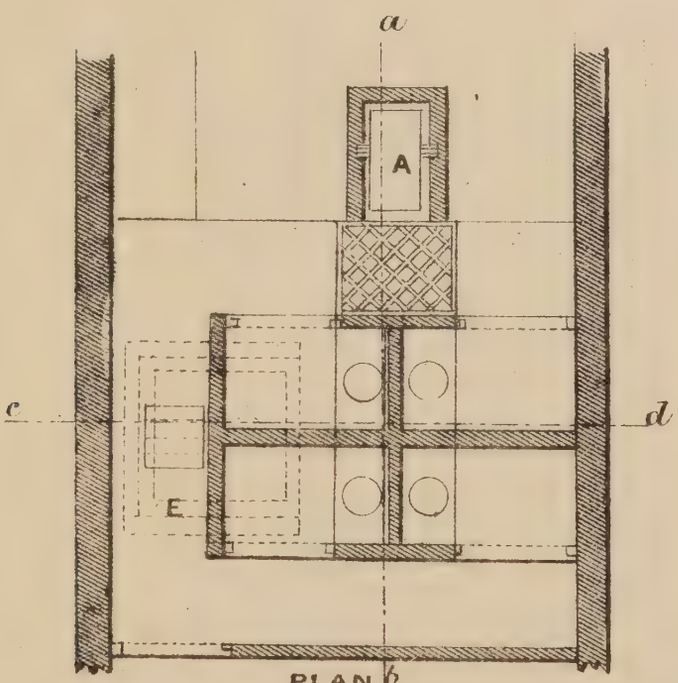
TUMBLER WATER CLOSETS, HENRY STREET LEEDS.



LONGITUDINAL SECTION (a b)

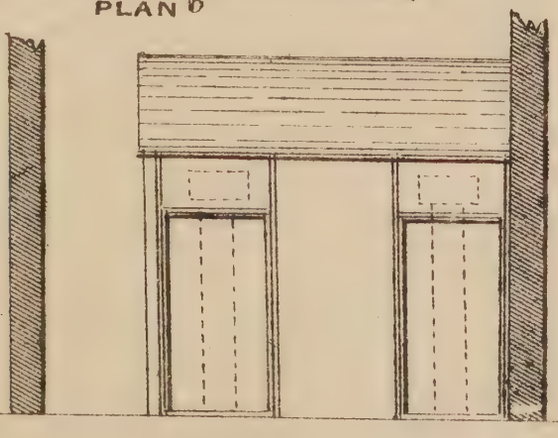


TRANSVERSE SECTION (c d)



PLAN

A Tumbler to flush trough.
B Trough below 4 Seats shown on Plan.
C Siphon trap with (D) cleansing shaft.
D Sunk dry ashpit.



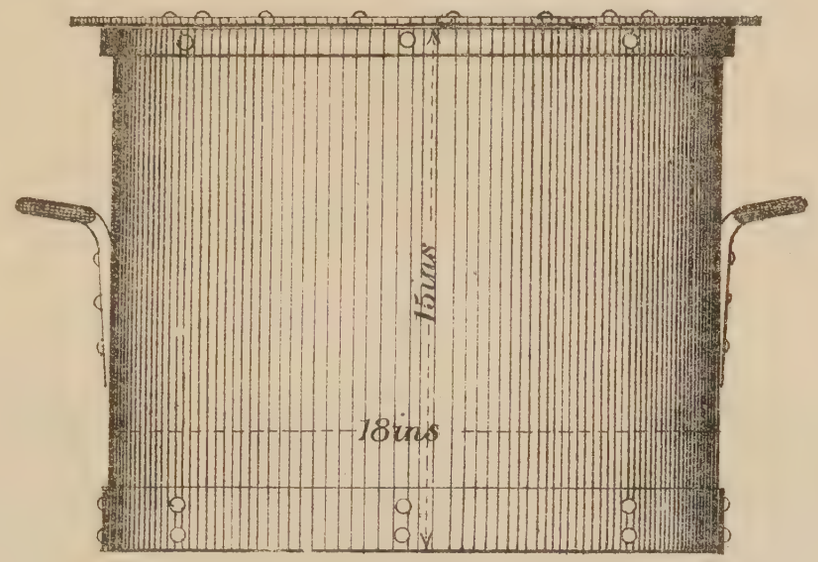
ELEVATION

Scale 8 Feet to 1 Inch

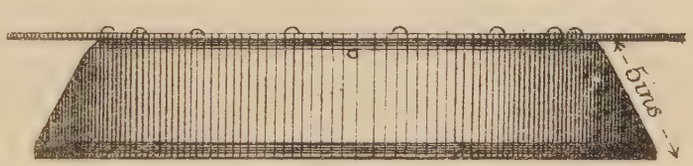
12 6 0 1 2 3 4 5 10 15 20 Feet

BIRMINGHAM CORPORATION.

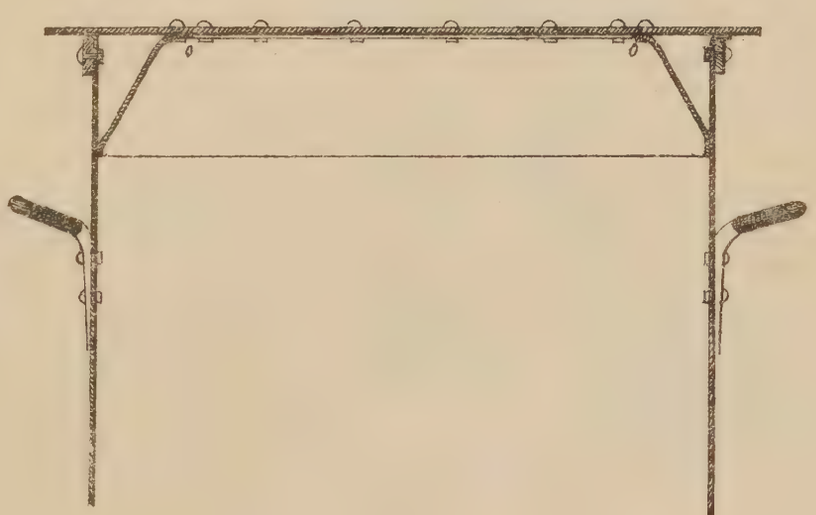
EXCREMENT PAIL.



PAIL.



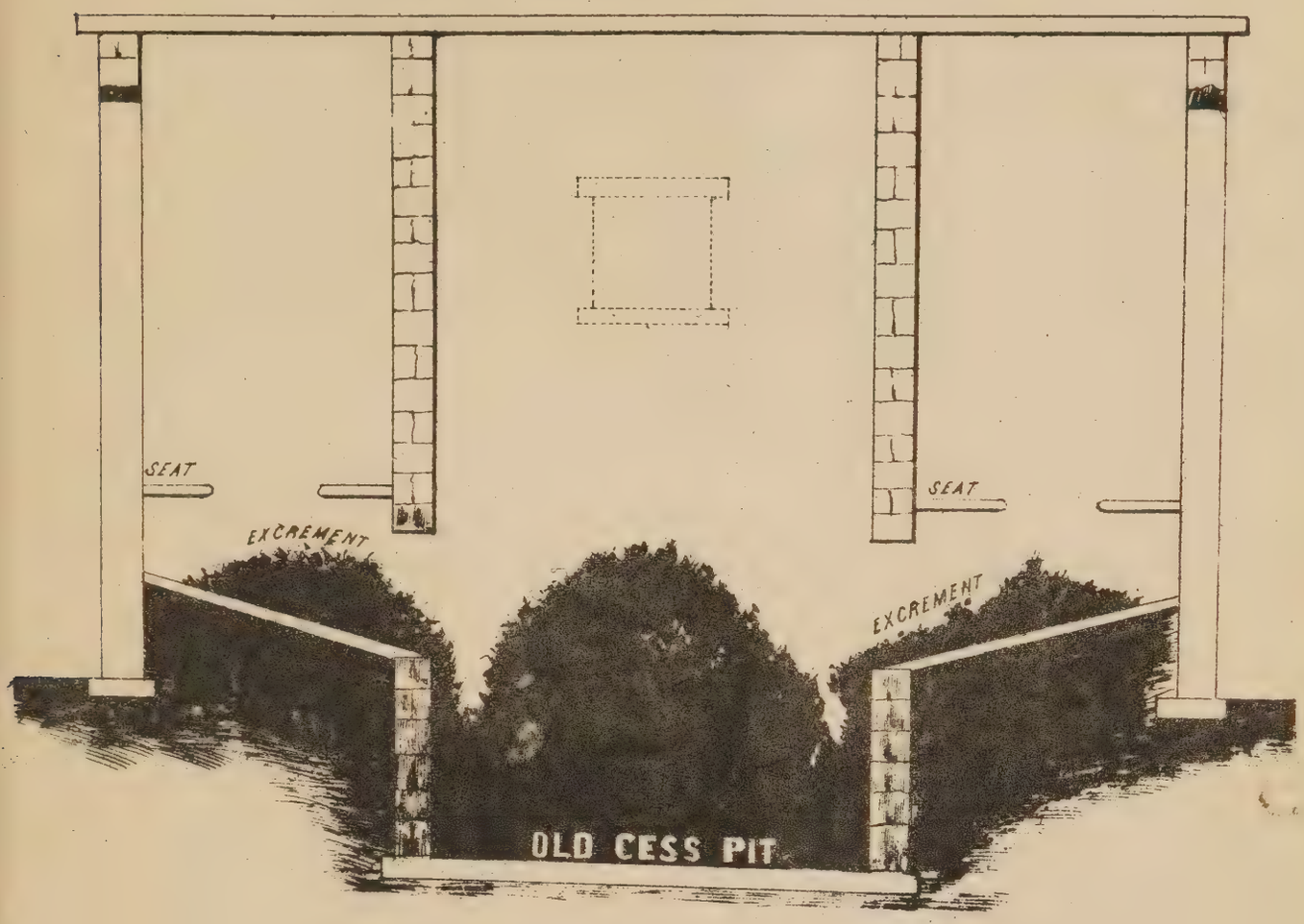
LID.



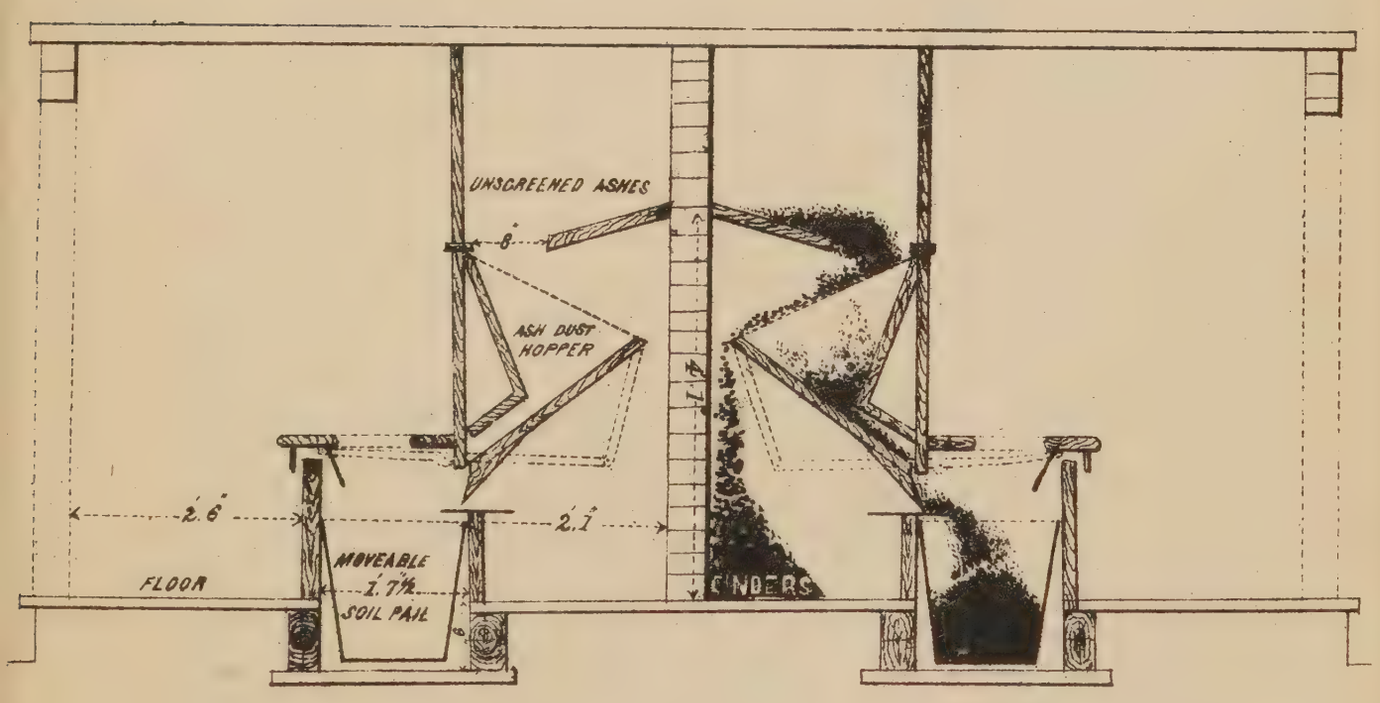
SECTION SHEWING THE LID IN POSITION.

Dangerfield, Lith. London.

SALFORD CORPORATION.



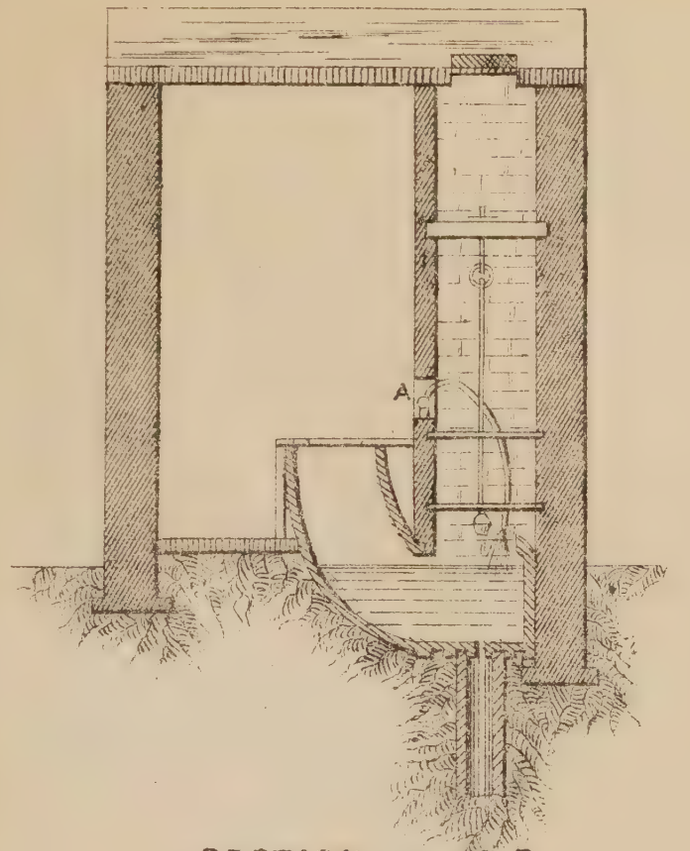
Section of old Closets,
Mc Cleary St Pendleton.



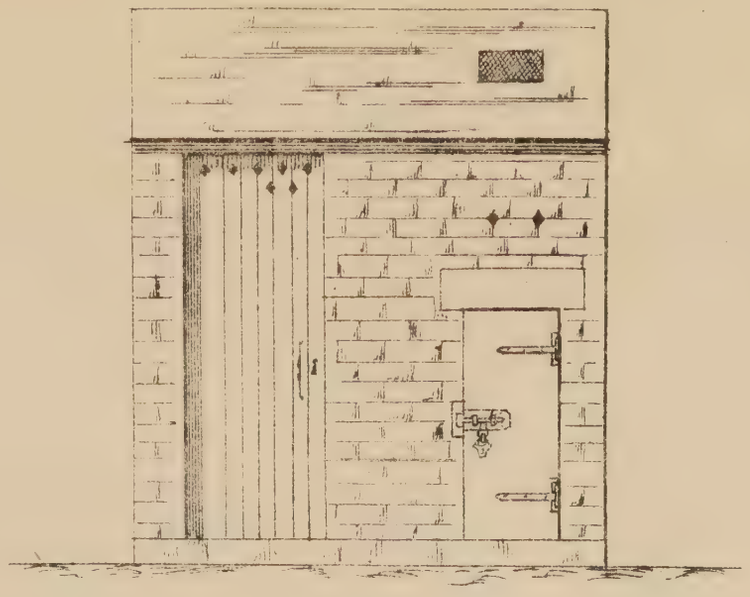
Section of Improved Closets,
with moveable Soil Pan, Morell's arrangement.
Mc Cleary St Pendleton.

Dangerfield, Lith. London

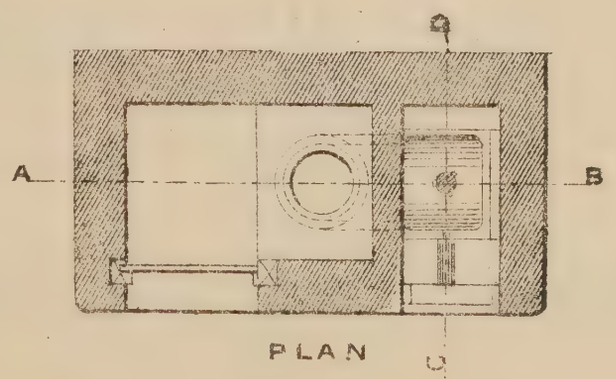
LIVERPOOL CORPORATION.—TROUGH WATER CLOSET.



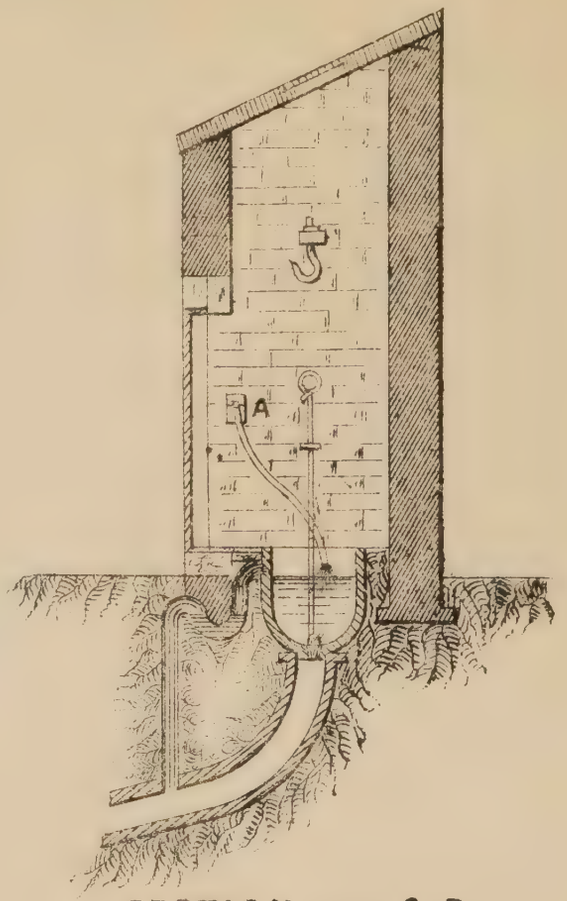
SECTION THRO A.B.



ELEVATION



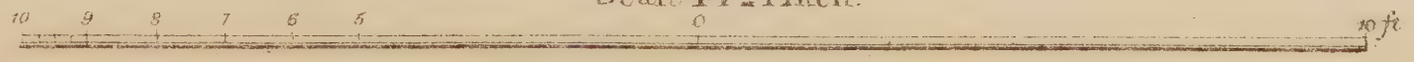
PLAN



SECTION THRO C.D.

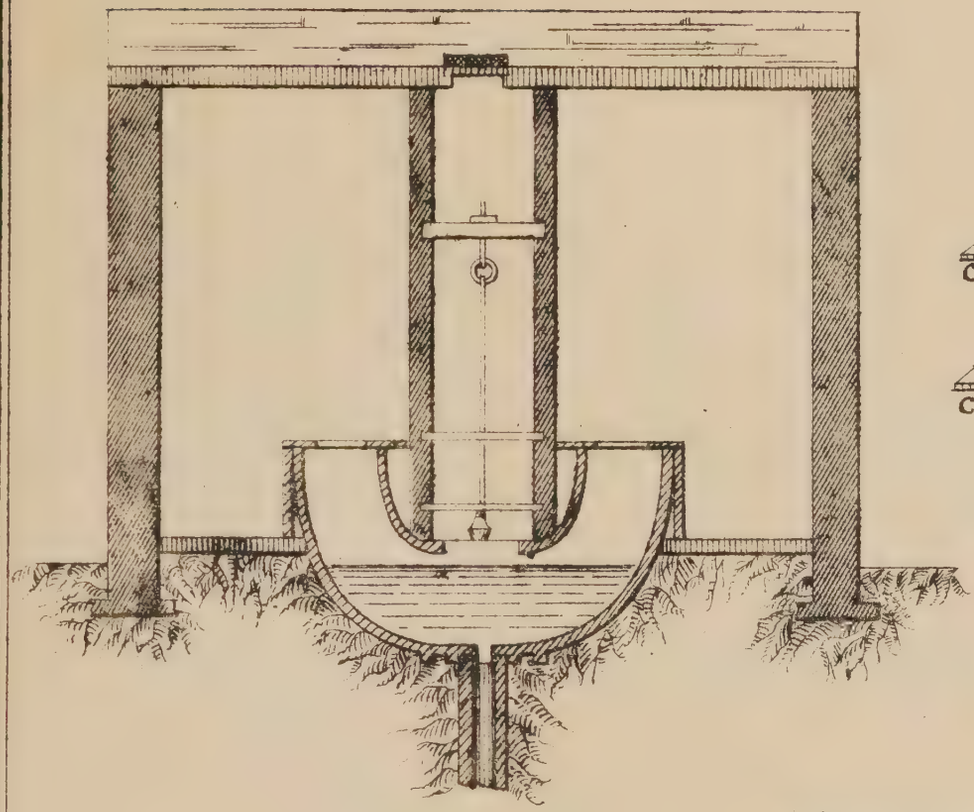
A *Water Supply from Hydrant with Hose inside Chamber.*

Scale 1 Ft. 1 Inch.

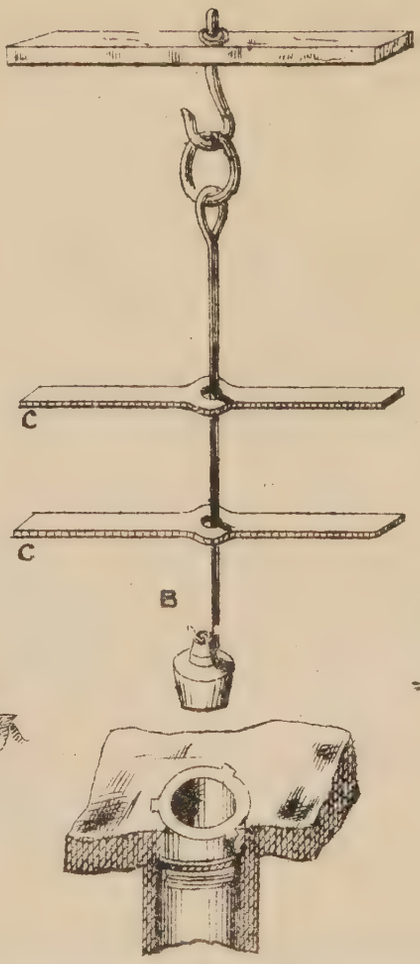


Dangerfield, Lith. London

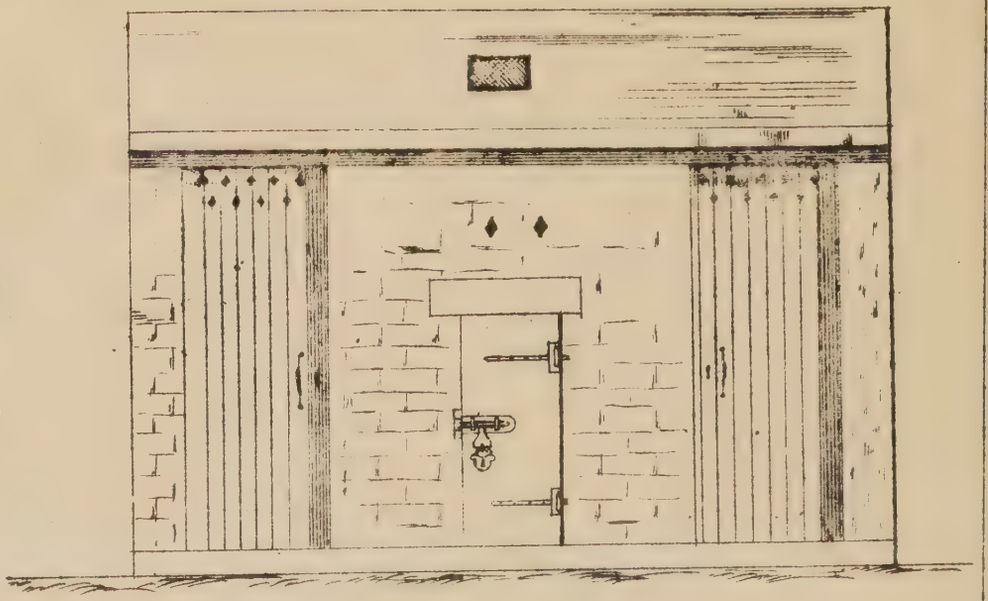
LIVERPOOL CORPORATION. DOUBLE TROUGH WATER CLOSET.



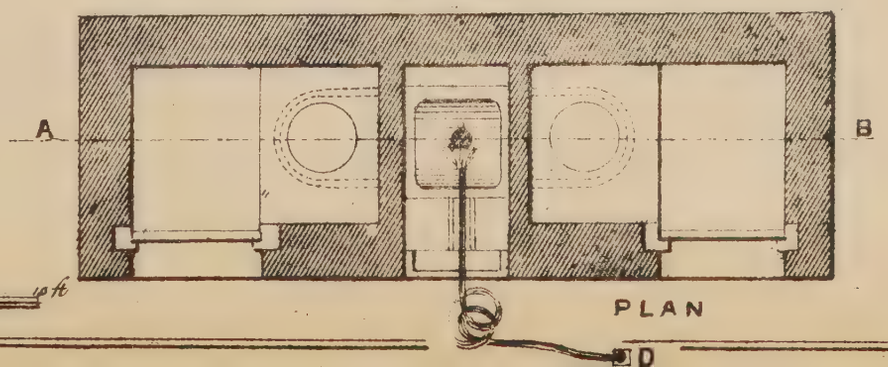
SECTION THRO A.B.



B. *Enlarged Drawing of Valve, Guide rods* (C) *&c.*



ELEVATION



PLAN

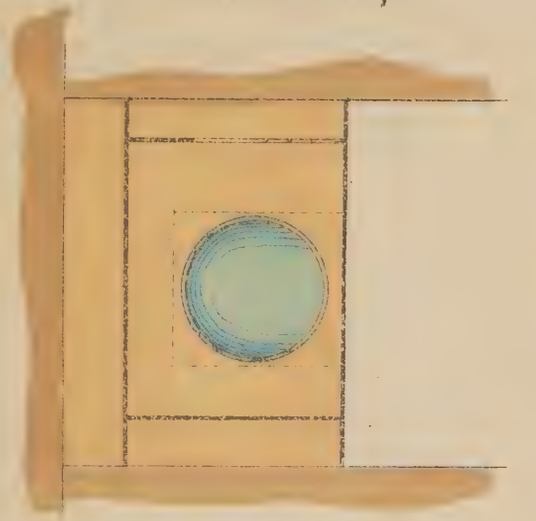
D *Water supply with Hose from Hydrant fixed in Court*

Scale 4 Feet-1 Inch.

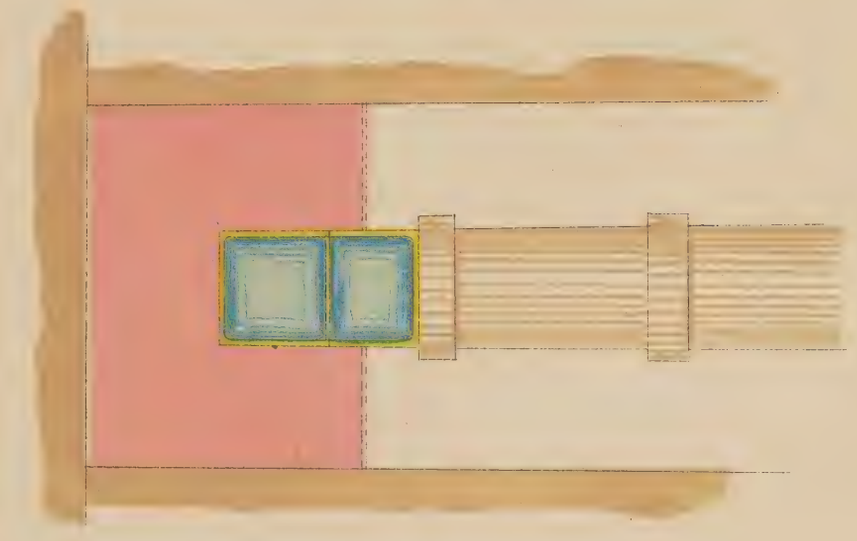
BRISTOL CORPORATION.

DRAWING OF COMMON PRIVY.

Plan at top



Plan at bottom



Section.

REFERENCE.

- *brickwork.*
- *freestone.*
- *woodwork.*

SCALES.

Plans ½ Inch to a Foot.

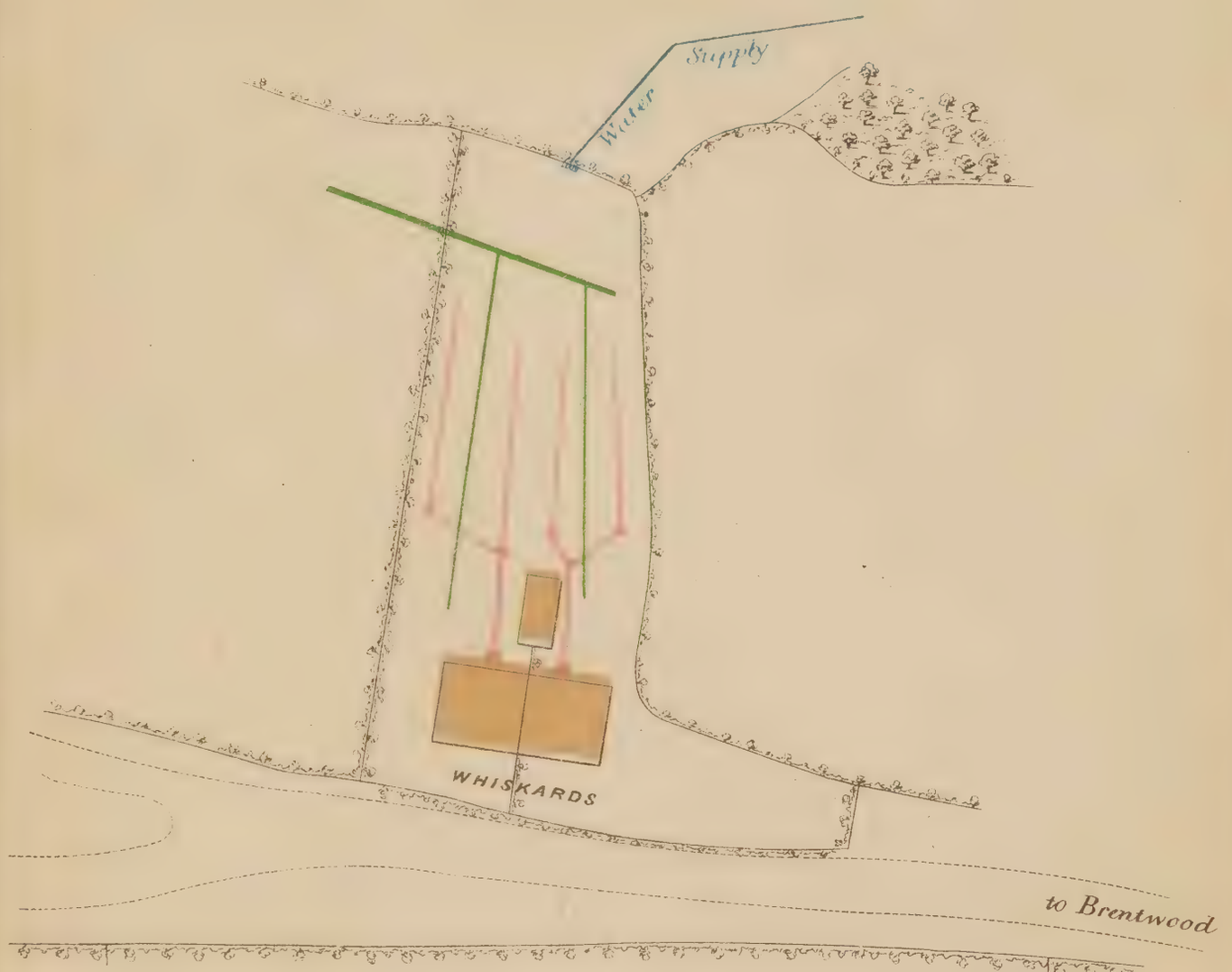
Section ¼ " " "

Mr Netten Radcliffe's Report.

PLATE XXXIV.

Fields Patent Siphon Tank.

PLAN OF COTTAGES & GARDENS
AT
SHENFIELD ESSEX.



REFERENCE

Siphon Tanks shewn	thus	
Watertight Drains	"	
Inspection Wells	"	
Subirrigation Drains (1 Ft deep)	"	
Land Drains (4 Ft deep)	"	

	a	r	p
Total Area of Land & Buildings	0	1	9
Area of Land irrigated about	0	0	14

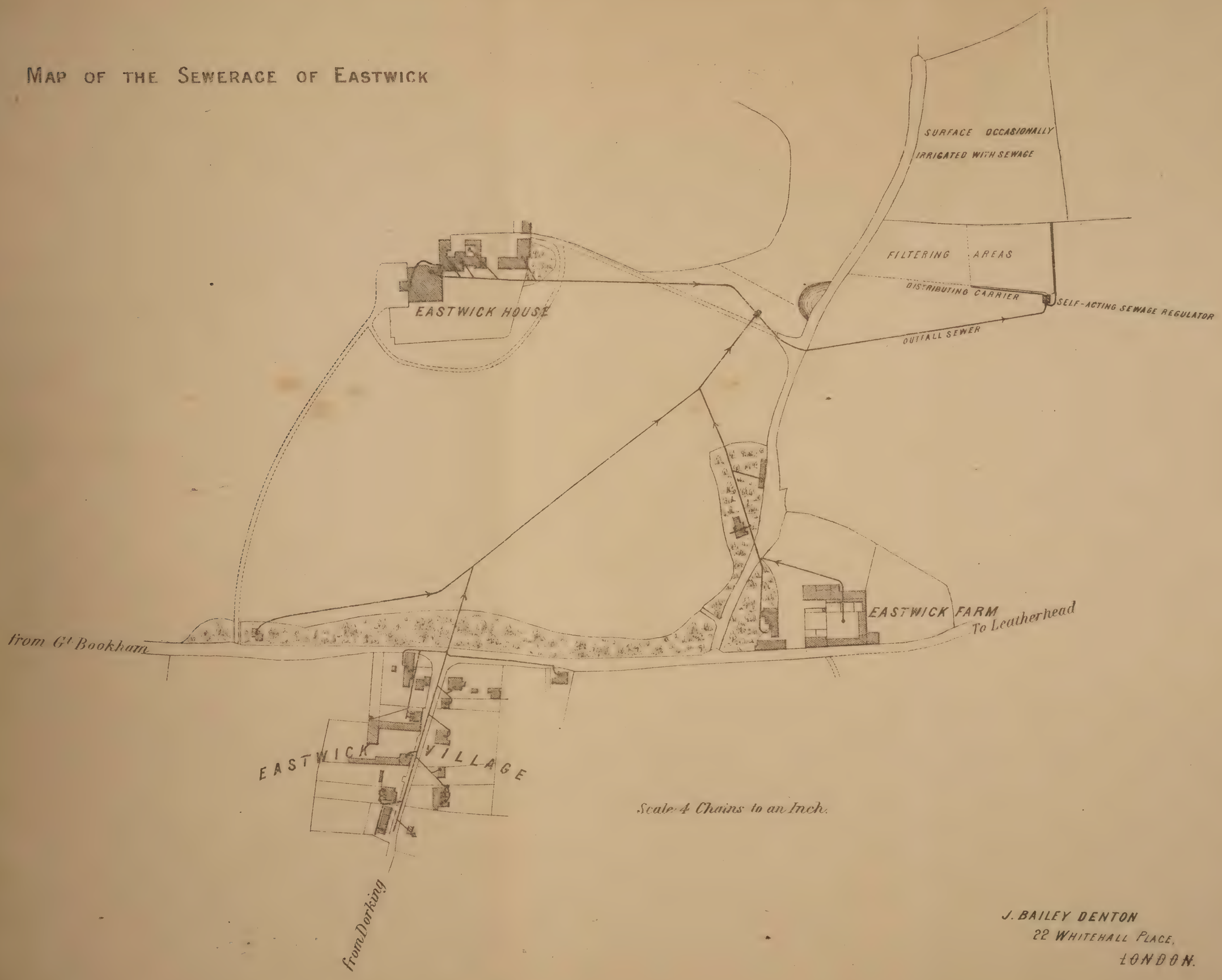
Scale 66 Feet = One Inch.

100 90 80 70 60 50 40 30 20 10 0 100 200 FEET

5 Cannon Row,
Westminster
Sept.r 1873.

Dangerfield, Lith London

MAP OF THE SEWERAGE OF EASTWICK



Scale 4 Chains to an Inch.

J. BAILEY DENTON
22 WHITEHALL PLACE,
LONDON.

Dangerfield lith, 22, Bedford St Covent Garden

London School of Hygiene & Tropical Medicine
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18 MAY 1932